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The MONTHLY REVIEW

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for the Advancement of the Science of
Electro-Plating

FEBRUARY, 1936 · IN THIS ISSUE

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The MONTHLY REVIEW

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Convention Notes

If our membership had the opportunity of accompanying your scribe on a trip to the offices of the Cleveland Convention Bureau they would feel certain of the success of the coming Convention to be held in Cleveland June 1st, 2nd, 3rd, 4th, 1936.

Of course you are by now aware that the date for the Convention has been moved forward a full week. As reported in the January REVIEW this has been occasioned by the selection of Cleveland by the National Republican Committee for its 1936 Convention. Our visit to the Convention Bureau offices, on the sixteenth floor of the Terminal Building was the result of this decision. Here one finds a large force of clerks answering the queries of many individuals and mailing the prospectuses the Bureau provides giving the many advantages of a Convention held in Cleveland.

At the time of our visit the Manager was occupied in obtaining accommodations for the large influx of delegates and visitors who are already reserving space in Cleveland for the week of the Republican Convention. I was told that as much detail work and attention is required reserving a single room in a private home as is needed in obtaining the reservations of an entire floor in one of the City's many large Hotels.

The Manager however was able to find time for a conference on the problems as presented in handling the Convention of this Organization, and exhibited as much interest in helping in their solution as had been noticed in the handling of other matters.

If you do not plan to bring your wife with you to this Convention I would advise that you keep from her sight all notices that will appear in the future issues of the REVIEW for when she reads about the many items of entertainment that our Ladies Committee have under discussion you will be certain that she will want to come along. You may be jealous of the opportunities that are to be given the ladies in sight seeing and visits to the many points of interest, and be tempted to cut a session in order to keep up with the wife's knowledge of Cleveland.

Such instructive trips as the "Home in the Sky", a visit to Nela Park, a luncheon and lecture at the Cleveland Museum of Art and many alternative shopping tours are being considered for the ladies, while equally instructive plant visitations are being arranged for the men.

You will also be interested to note that Cleveland is repeating the Exhibition of equipment and supplies as held in Bridgeport last year and looks forward to a larger show than we enjoyed there. We have been able to obtain a hotel which has sufficient exhibit space in two units to enable us to offer 107 booths. We feel fortunate in being able to induce Mr. R. T. Phipps, who managed the Bridgeport show, to take over the 1936 Show. Through the co-operation of Mr. Harry G. Dean, an official of the Hotel Carter, Mr. Phipps is able to have on the immediate scene of activities one long experienced in the management of Conventions and Exhibits. Mr. Phipps has already spent some time in Cleveland going over the exhibit possibilities in the Hotel Carter and will again be on hand to personally manage the erection and display of the various suppliers' equipment.

Owing to the physical character of the public space in the Carter we will be able to have operative exhibits of all types on display and still not be crowded as to adequate space for our Educational Sessions and Banquet. From the crumbs of information dropped by the members of our Banquet Committee, we feel that this feature alone will long remain in the memories of those in attendance. From the names of popular radio bands, ensemble members, individual artists to be chosen from, one gets the idea that he is eavesdropping on a group of radio officials instead of the Banquet Committee members.

O yes, one thing bears mentioning this month and that is make your reservations early for hotel accommodations, especially if you intend to remain over for the Presidential Convention.

Be very specific in stating how long you will need your rooms and the price range preferred. We will give you full hotel information next month.

No matter how early you write for your reservations you will not be first, since the Hotel Manager Mr. Cruse, tells me that he has already booked rooms for our Convention.

For those who have not been in Cleveland as yet, our photographer is preparing a series of views of outstanding spots for your information. We expect to have them ready for the March issue. Watch for them.

The **Adhesion** *of Electrodeposits*

By WALTER R. MEYER

Read at Bridgeport 1935 Convention

A PHASE of the important subject of the adhesion of electrodeposits has been considered at almost every annual convention of the American Electro-Platers' Society. The papers of Hogaboom, Castell, and Romanoff, which were presented at Detroit, were notable contributions to the subject. This afternoon an effort will be made, with the help of slides and demonstrations, to correlate previous data and to add our work of the past year pertaining to the adhesion of electrodeposits.

In the electroplaters' terminology, the word "adhesion" may be defined as the force which is required to effect a separation of the electrodeposit from the basis metal either at the metal to metal interface, or through a diffusion boundary. The inter-atomic forces causing adhesion fall off very rapidly as the inter-atomic distance is increased and from Dushman's[1] calculations vary inversely as the fourth power of the inter-atomic distance. This means, for example, that if the force were 64 lbs. at 1 unit distance, it would drop to only 4 lbs. if the inter-atomic distance were doubled. The distances between the atoms at which the forces of adhesion and cohesion become insignificant are of the order of 50 Angstrom units (50×10^{-8} cm.) which is approximately two ten-millionths of an inch (.0000002").

There is little wonder, then, that traces of oxides or grease cause non-adherence of the electroplate when they need be only one-hundredth as thick as the thin chromium deposits that are usually applied. By this it is not implied that an adherent coating cannot be deposited on an oxide film, but rather that the force of adhesion will only be of high magnitude when the thickness of the oxide is less than 50 Angstrom units. Hothersall[3], for example, succeeded in depositing a strongly adherent nickel plate to an oxide film on steel. The electrical conductivity of the oxide film is, however, another important factor to be considered.

BASIS METAL

The electroplater has learned from long experience that not

only must each metal be processed differently, but each alloy of a binary or complex system as well. We will shortly hear, for example, of season cracking of brasses induced by cold-work strains. We have heard much of the possible relationships of cold-work strains to adhesion during the past year, and I would like to caution against placing undue importance upon their assumed effects, lest we blind ourselves to more salient factors leading to exfoliation of electro-coatings. The writer has found few cases of peeling directly traceable to cold-work strains in the body of the metal itself.

Grain growth, as was experienced with zinc alloys containing aluminum and tin, season cracking, or shrinkage cracks, will seldom cause peeling of the electrodeposit if it has been properly applied but rather will cause cracking by notch propogation. Cracked nickel deposits on lead basis metals have been ascribed by Mr. Hogaboom to be due to cold-work strains present in the basis metal from polishing or buffing. These hairline cracks are not due to cold-work strains in the lead alloy, but result from the inherent strains in the electrodeposited nickel. We have produced these cracks many times on annealed lead specimens and on lead alloys which had been etched sufficiently to show the normal crystal structure. The photomicrographs will clearly show this point. Similar cracking tendencies have been observed by E. A. Anderson for nickel on zinc die castings, and by Romanoff for nickel on copper as a basis metal. We must seek the answer for the cracking in the relative tensile strengths and coefficients of expansion for the electrodeposit and basis metal, as well as the strains in the electrodeposit.

Holes beneath the surface of the basis metal have often developed into blisters in the pickling or plating processes, which blisters have been attributed to faulty plating. We have repeatedly observed this in zinc base die castings, slush lead alloy castings, iron castings and Bardenheuer and Ploum[4] reported it for electro-pickled steel wire. These defects may be truly blamed on the basis metal.

POLISHING AND BUFFING

Surfaces which are rough from casting, grinding or etching give more adherent electrodeposits. This is due to increased

1-3 (For Literature References see page 12.)

area of contact and to mechanical interlocking of the deposit in undercut crevices. Slides will be shown to illustrate the last point. Polishing and buffing may actually lead to poor adhesion due to cold-working of the surface film with corresponding lowering of ductility and greater susceptibility to hydrogen embrittlement. Hothersall has reported this effect for nickel plated brass and the author has observed it for nickel plated zinc. These cold-worked surfaces can be removed by deep etching, which expedient cannot be employed, however, when a bright finish must be maintained. Time will not permit an extended discussion of the effects of polish on metals or the interpretation of the so-called "amorphous" layer. This the writer has already done for the Society in a previous issue of the MONTHLY REVIEW.

CLEANING

The faulty removal of oil, grease films, and solid dirt has been the stereotyped answer to peeling difficulties from the dawn of electroplating, and particularly prior to the use of chromium, heavy deposits and high current densities. We will grant the fundamental that the work is cleaned to no water-break and even then we may have peeling due to faulty cleaning. The difficulties may be threefold, namely, hydrogen embrittlement, plating action of the electrocleaner, and the presence of hydrophilic colloids. Hydrogen embrittlement may lead to cracking of the basis metal as, for example, with steel springs, or to embrittlement of the electrodeposit with resultant cracking or peeling. Nickel coatings are particularly susceptible to hydrogen embrittlement.

The effects of colloids on adhesion have been studied for copper deposits by Pierre Jacquet[5]. Jacquet has found that if the cathode is immersed in a solution with .0005 oz./gal. of serum albumin, .002 oz./gal. of peptone or .003 oz./gal. of glue, non-adherence may result due to the deposition of the colloid on the work. Even boiling water will not remove the film. This action could take place if a hydrophilic colloid were present in either the cleaner or the plating solution, although the effects are more pronounced when the solution pH is below the isoelectric point of the protein as in acid copper, zinc or low pH nickel baths.

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[4] (For Literature References see page 12.)

Although the iso-electric pH of gelatin is 4.7, Ballay claims that .004 oz./gal. of gelatin will ruin the adhesion of nickel with a pH between 5.5 and 6.5. There is still much work to be done on the absorption of colloids by metals but the data accumulated thus far suffice to warn us not to add organic addition agents to our plating baths without careful investigation.

Practice has taught us that it is often false economy to use our electrocleaner indefinitely without making a new bath. After the electrocleaner has been in use for some time, a black smut will begin to form on the work if made the cathode. This smut may consist of iron, copper, lead, zinc or tin, is poorly adherent, and often will not dissolve in an acid or cyanide dip and may lead to peeling of the electrocoating. Reversal of the current will deplate some of the constituents, namely zinc, tin and lead, and will render the iron and copper more easily soluble in the acid dip. If the cleaner plates a noticeable smut, the work should either be cleaned anodically, or with no current, or discarded entirely.

Non-adherent films may form on the work in electrocleaning and cathodic electropickling by reduction of heavy oxide films resulting in contraction of the oxide and a spongy metallic film.

PICKLING

Pickling and acid dipping, either with or without current, serve several purposes: Removal of oxides and cold-worked surfaces and neutralization of any alkaline film carried over from the cleaner. If the cleaner contains soap, the work must be carefully rinsed to prevent the formation of free fatty acid in the acid dip. One factor in acid dipping that frequently causes non-adherence is smut formation due to preferential solution. This is common for carbon in iron, copper and silicon in aluminum and for copper in zinc alloys. Control of time, temperature and concentration of acid will prevent this difficulty.

PLATING

The difficulties that may arise in the various plating solutions and in their application would carry far beyond the scope of this paper. Four problems will be discussed, namely, film carry-over, alkaline film, current density, and buckling stresses.

(For Literature References see page 12.)

FILM CARRY-OVER

Cyanides and alkalis cling tenaciously to metals and if not destroyed may be carried into the plating solution and result in a precipitation of insoluble salts on the work to be plated. Wherever possible, acid dips should immediately precede acid plating and cyanide dips before cyanide plating baths.

ALKALINE FILM

In neutral and even in acid plating baths, whenever the cathode efficiency drops below one hundred per cent, an alkaline film forms adjacent to the cathode because of the discharge of hydrogen. For many years it was believed that the hardness of nickel was due to the codeposition of hydrogen per se. MacNaughton[6] and his collaborators have proved that the hardness of nickel deposits is due to the formation and codeposition of hydroxides, and is not a function of the amount of hydrogen evolved. Professor Desch suggests the interesting possibility that the codeposited matter may be finely dispersed throughout the crystals, resulting in a hardness mechanism similar to that of age hardening of alloys. Codeposition of basic compounds has been observed in both acid and basic solutions for zinc, cadmium and copper.

Dr. R. R. Rogers[7] in a recently published paper deals at length with this alkaline film, particularly in regard to presenting a theory for the deposition of chromium. He states that this film must have a definite pH value for metal deposition to take place and that the final metal deposition is by hydrogen reduction from chromous hydroxide and not by electron interchange between charged metal ions and cathode.

CURRENT DENSITY

Current density which is calculated as an average current over a given area does not give a picture of the maximum and minimum current at points or recesses. The difficulty in obtaining complete coverage in chromium plating brought the point strongly to our attention, although this difficulty was long recognized by the silver plater. We have found current densities varying over 400 per cent on simple sheets. Dr. H. Lukens, who has studied equipotential points in plating solutions by means of exploratory electrodes, will bring out these facts very clearly in his paper Tuesday evening.

The local high current density points which result in "burned", brittle deposits often result in peeling in spite of ideal preparation of the basis metal. Current stealers and increasing the distance between anode and cathode are the remedies.

BUCKLING STRESSES

Almost all electrodeposits are produced with inherent stresses and in the case of nickel the deposits are frequently harder than it is possible to harden cast nickel by rolling. The exact nature of the hardness has not been completely determined. In the case of chromium, it may be due to fine grain size, hydride formation, lattice distortion or codeposition of basic or colloidal material. In general, the finer grained plates are less ductile and harder than the coarser grained deposits. A vast amount of research work confronts us on the effects of anions, cations, current density, temperature, and so on, on the buckling stresses and hardness of electrodeposits.

Dr. E. A. Vuilleumier, our last speaker on the program, has investigated the buckling stresses by depositing the plate on one side of a thin foil. For nickel he has observed contraction. C. Marie and N. Thom[8] found that a small amount of hydroxylamine added to an acid copper solution changed the strain from contraction to expansion. Using similar methods, the writer has observed strong contraction tendencies for chromium. These stresses may become greater than the forces of adhesion resulting in peeling or when the adhesion is good, they may result in cracking.

Why does as little as one hundred thousandths of an inch of chromium have such a pronounced tendency to cause nickel to peel from the basis metal. Is it purely hydrogen embrittlement during chromium plating? According to Schlotter, hydrogen embrittlement plus a gas pressure between the nickel plate and the basis metal are responsible for peeling. In a study of the effects of cathodic hydrogen on nickel chrome plated lead-antimony alloys, we have found that the above factors are not the only causes for peeling, even when "perfect" processing may have been done. Sheets were coated with .0005″ Ni and .00002″ chromium and half of the chromium was removed with HCl. The plates were subjected to cathodic hydrogen which caused blistering within two minutes of the nickel-chrome portion,

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6.7 (For Literature References see page 12.)

whereas no blistering occurred on the nickel sheet after thirty minutes of hydrogen treatment. The marked difference between the effect of hydrogen on nickel with and without chrome may be attributed to differences in hydrogen overvoltage as suggested by Dr. R. W. Mitchell[9], or to the additive buckling stress of the chromium deposit.

COEFFICIENTS OF EXPANSION

The differences in coefficients of expansion between the electroplate and the basis metal may lead to cracking, but seldom to flaking or peeling. Dr. Bauer[10] and his co-workers have produced cracking of chromium plating on brass by alternate heating and cooling. The application of nickel as an intermediary coating prevented this cracking because nickel has a coefficient of expansion between that of brass and chromium. The coefficients of expansion for some common metals for degrees Centigrade are:

Chromium	8.4×10^{-6}
Iron	11.6×10
Nickel	13×10
Copper	16.5×10
Brass	20×10
Lead	29.5×10
Zinc	35.4×10

Note that the coefficient of expansion for zinc is over four times that of chromium, which fact may partly account for the cracking of chromium plating directly on zinc.

In a study of brittle undercoats from diffusion between copper and zinc, the writer found that 100 alternate immersions in boiling water and ice water failed to cause exfoliation, whereas a very slight bend in the plate caused the alloy to fly off the plate, indicating that ductility relationships are far more important than relative coefficients of expansion for peeling.

DIFFUSION

Diffusion between electrodeposits and the basis metal has been observed for many years for gold on lead, copper on aluminum and zinc, and cadmium on copper and iron.

J. Turner[11] in 1912, Hudson[12] in 1914, H. Weiss[13] in 1920, Dr. C. F. Elam[14], W. Kohler[15] in 1928, and in the last few years,

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8-9-10-11-12-13-14-15 (For Literature References see page 12.)

Chujiro Matano,[16] Yamauchi[17] and Castell[18] have studied the diffusion velocities between copper and zinc. There is no question that the diffusion is largely from copper into the zinc, and Binayendra Nath Sen[19] recently suggested the direction of diffusion in general is from the solid with smaller interatomic distance into the solid with the larger interatomic distance. The adhesion may increase or decrease depending upon the physical properties of the diffusion alloy. When the metals form solid solution throughout the composition ranges, as with copper and nickel, perfect adhesion may result. When the diffusion alloys are more brittle than either metal, as is the case with copper and zinc, and iron and zinc, peeling may result especially if the plate is subjected to flexing. May I emphasize the fact that the peeling is not due to disappearance of the diffused coating or to lowered tensile strength, but primarily due to the sharp decrease in ductility.

CONCLUSIONS

To attempt a summary of the conditions leading to non-adherence is difficult. No claim has been made for completeness of difficulties that may arise or have manifested themselves in your every day work. It is my hope, however, that the major features either obvious or unsuspected have been covered to better enable you to meet the challenge of future rigid control and application of heavy coatings.

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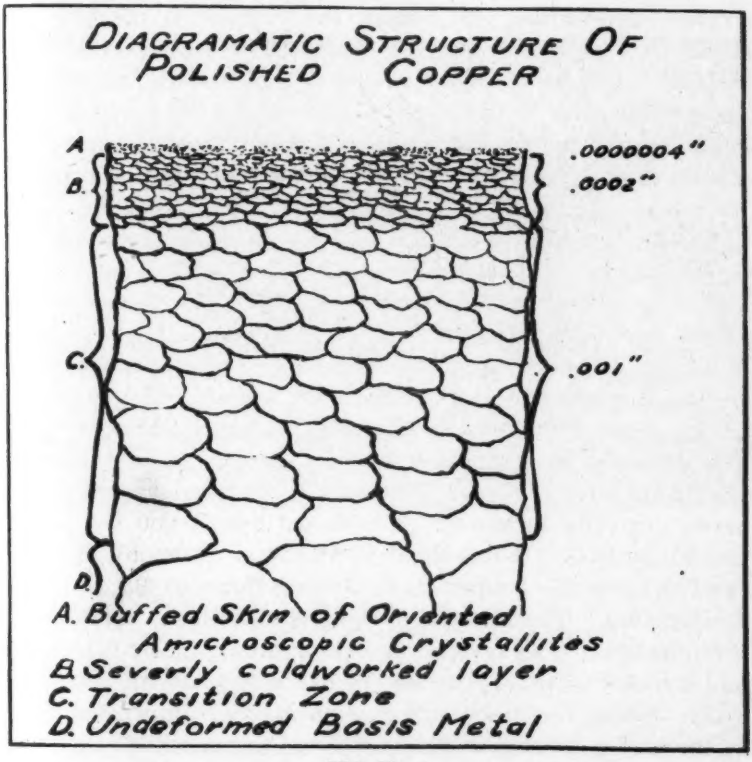


Slide No. 1

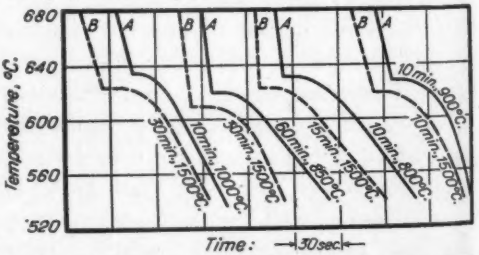
(*Slide* No. 1) This cut was taken from the February 1935 issue. It is based on electron diffraction work and x-ray work of Boas & Schmidt. It is purely diagramatic, but I am presenting it here to show the possible effects of cold-working of surfaces on the basis metal itself. You will note that there is a very thin layer of severely cold-worked material which has been the bone of contention between various men for the past twenty or thirty years as to whether it is crystalline, amorphous, or colloidal. You will note I put the thicknesses four ten-millionths of an inch. Hopkins, in the Faraday Society meeting, which Dr. Blum attended, found it to be about one-half or one-quarter.

The next layer beneath the severely worked layer is a layer of oriented crystallites. They have a definite orientation in the direction of polishing. They are severely cold-worked and are very brittle. Then you get a transitional zone through to the

crystals themselves. Of course, every metal is not like this. It depends upon the ease with which a metal is cold-worked. It depends upon the force and pressure applied to the material. I should like to point this out, and this was one point I tried to make clear in my publication, and that is in normal plating processes, this "A" layer which you can call amorphous, if you want to, is removed and we get down in here into the "B" zone. That "B" zone is definitely crystalline, but you do not reproduce the basic crystals because of the smaller crystalline size of those materials themselves. Sometimes you may etch deeply enough to get down into the crystals of the basis metal.

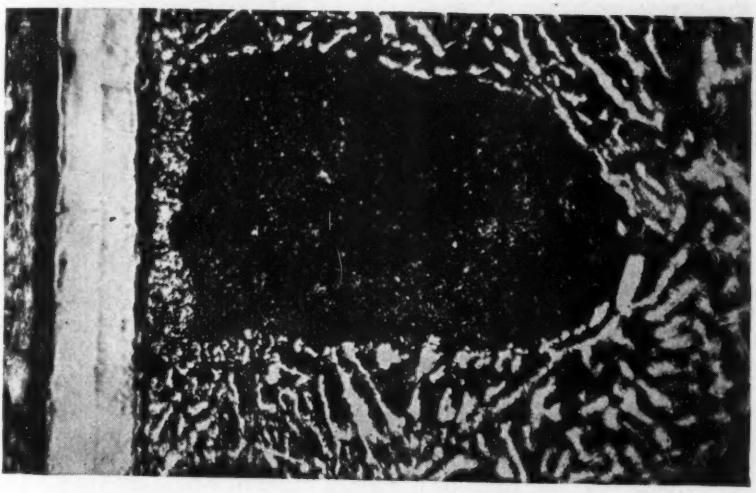
(*Slide No.* 2) I am rather proud of this slide. It shows very clearly the effect of cold-working, and it gives you an idea of the depth of penetration of cold-working. I meant to show this tomorrow, but I thought I would show it today to illustrate the point I have in mind. This is antimonial-lead, approximately seven per cent antimony. This huge crystal you see here is essentially lead. It has slight solubility of antimony in it, depending upon the temperature. It runs down to .25% at room temperature. The interesting thing is right here. Notice this precipitation. This crystal ran over in here. There is a copper and a nickel plate, approximately half a thousandth of an inch each. Notice the precipitation of antimony from solid solution of the lead. It extends about five ten-thousandths of an inch below the surface. I was not looking for that when I took the picture; I was looking for something else. I have some other slides to show that same particular phenomenon.

(*Slide No.* 3) Here are a few cooling curves to show the effect of super-heating on super-cooling. The normal melting point of aluminum, I believe, is 660. Notice that when you heat higher above the melting-point, say in this case, you get a greater degree of



Cooling Curves of Commercially Pure Aluminum; Split Heats Poured Into Chamotte Molds, Cold or Preheated. "A" of each pair was held only a little above the melting point; "B" had been superheated as noted and furnace cooled to the pouring temperature of the first portion

Slide No. 3



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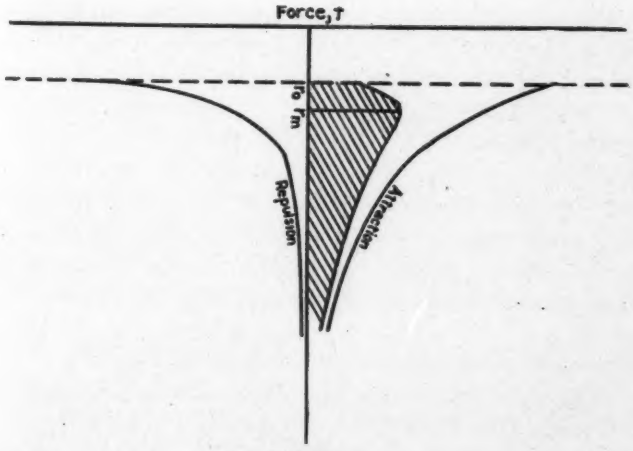


Slide No. 5

Superheating Reduces Nuclei

Metal	Melting Point	Temperature of Melt	Crystals per Unit Area
Al	660°C.	700°C.	110
		1300	62
		1900	45
Sb	630	800	100
		1350	12
Cu	1083	1100	72
		1700	55

Slide No. 4

super-cooling. (These are cooling curves), which seems to indicate that we have crystal nuclei which persist even in the molten state.

(*Slide No.* 4) Here are some actual determinations of crystals per unit area, with variations of temperature above the melting point of the metal concerned. This is aluminum. The melting point is 660. When heated to 700 degrees C., it has 110 crystals per unit area. On super-heating 1,900° you have only forty-five. It may be a way of making single crystals.

I am going to change for a minute to this screen over here, where I am going to try to show you buckling stresses present in the chromium plating solution.

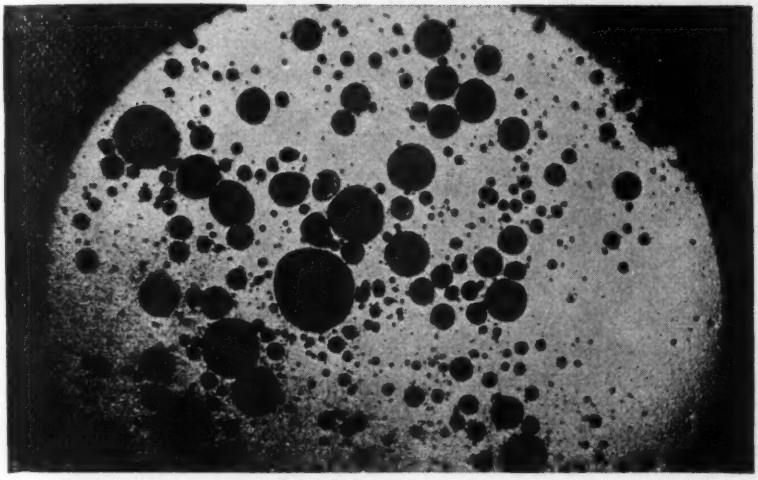
(*Motion picture*) This is the cathode and this is the anode. This is a very thin flexible cathode and this is a stiff anode. You will find that as the chromium begins to deposit on this metal, the film will buckle, showing a buckling tendency in the chromium plate itself. We cannot continue it very long, but I would like to have you watch it for a couple of minutes, anyway. See the way that goes over.

CHAIRMAN PHILLIPS: How thick is that?

MR. MEYER: About five-thousandths of an inch. I am stealing Professor Phillips' method of presenting plating solutions. I might say that some English workers have used this method in 1928 to actually photograph some processes in the plating solution. It is a very unique way of showing various phenomena.

Question: *What is that traveling around the anode*?

MR. MEYER: This is the top of the solution at the bottom of the screen. The anode is over to the left. This is the cathode. You can see the hydrogen bubbles. The efficiency of this, I dare say, is not much over ten per cent. These bubbles are just hydrogen bubbles that are attaching themselves to the



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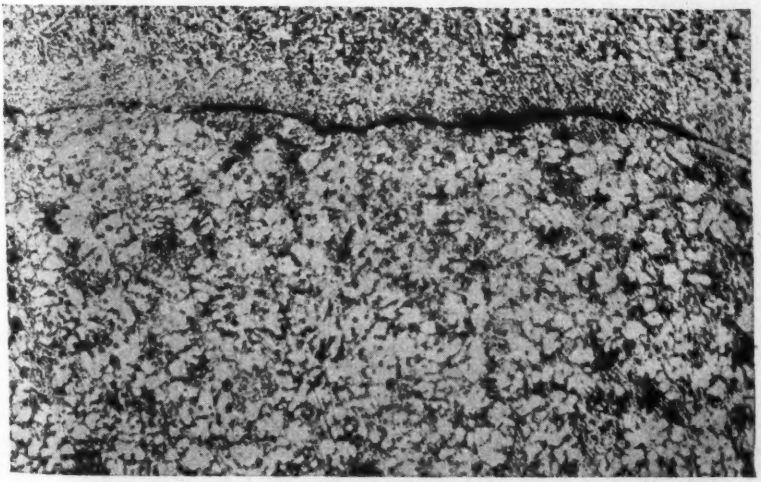


Slide No. 7

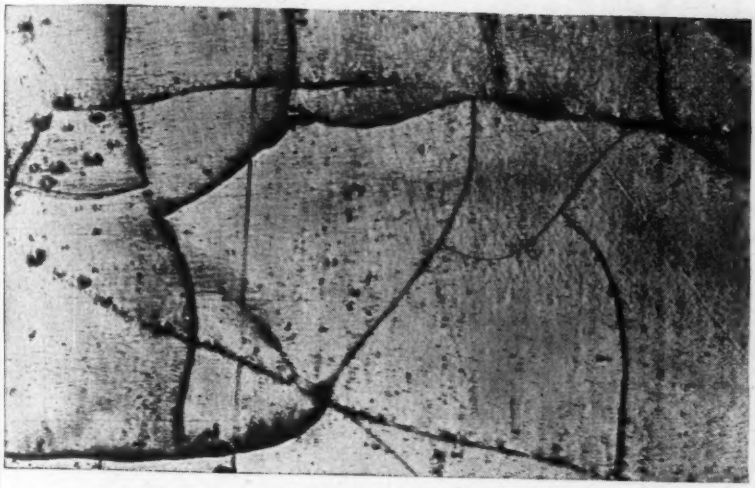
cathode. I was going to run the same demonstration with nickel, but it would repeat itself. You would see a cathode over here originally, and it would buckle over. It occurs with both nickel and chromium. When you put the two together, they have a greater tendency to peel. That is one of the reasons why chrome tends to cause nickel to peel.

Question: Have you ever done that with two anodes so that you got reasonable deposits on each side?

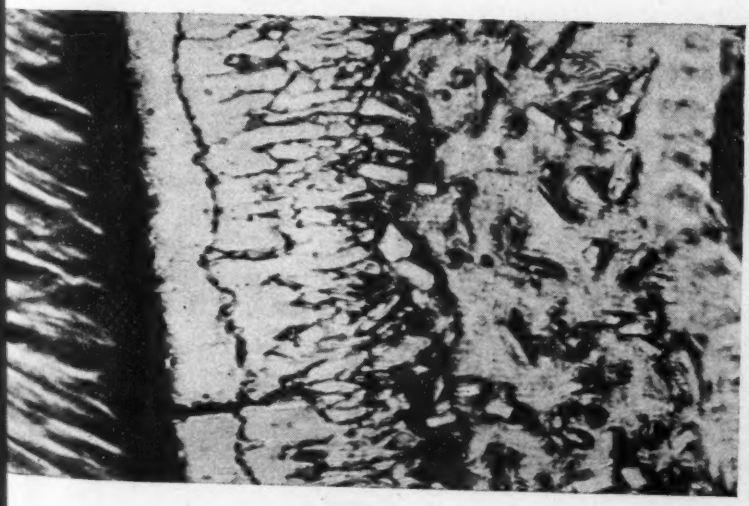
MR. MEYER: You would not get it if it were deposited equally on both sides. We use lacquer to prevent deposition of the plate on one side. It would defeat our purpose, of course, if it plated on both sides. You have metal deposit only on one side when you are plating on the normal surface.

(*Slide No.* 5) I am going to show you another very interesting demonstration over there at the end of the lecture. This is taken from Dushman's paper on "Cohesion and Atomic Structure", to show the way the force of inter-atomic attraction and inter-atomic repulsion vary as the inter-atomic distance is varied itself. Notice the force of attraction drops off much more slowly than the force of repulsion. The force of repulsion varies from the seventh to the fourteenth power, or the seventh to the eleventh power, and this is about the fourth power. The total area under this curve will represent the total energy to separate two atoms.

(*Slide No.* 6) Here is a picture of a zinc die casting or rather a cross section of a zinc die casting, that I picked up at random in the plant. I wanted to see if there were any holes in it. It is not the usual surface, fortunately, but it shows conditions that you might get. All of these little black spots are holes. As I was examining this piece under the microscope (I had washed it very thoroughly previous to that), I could see solution oozing out of the holes. I went back and washed it repeatedly and dried it, and still the chromium solution seemed to ooze out of the pores. It is extremely difficult to rinse all the solution out of these pores. We have found enough difficulty in that end of plating. That is probably an extreme case of porosity.



Slide No. 8



Slide No. 10

(*Slide No.* 7) Here is a picture of another die casting that was found in the plant. This is the edge of the specimen here. This skin probably runs one-hundredth of an inch below the surface. I accidentally happened to pick this spot and there was a nice crack there. That skin could lift off very well. Notice the marked difference in crystal size between the skin and the layer deeper in the metal.

(*Slide No.* 8) Here is a picture of cracking on zinc, which is entirely due to the stresses inherent in the nickel plate itself. These little centers of cracking are pits, pitting attendant with this solution. Such terrific stresses resulted from plating of that material; it contracted and formed those cracks. That is what you see. Those cracks are frequently transmitted to the basis metal beneath. I have some pictures to show that.

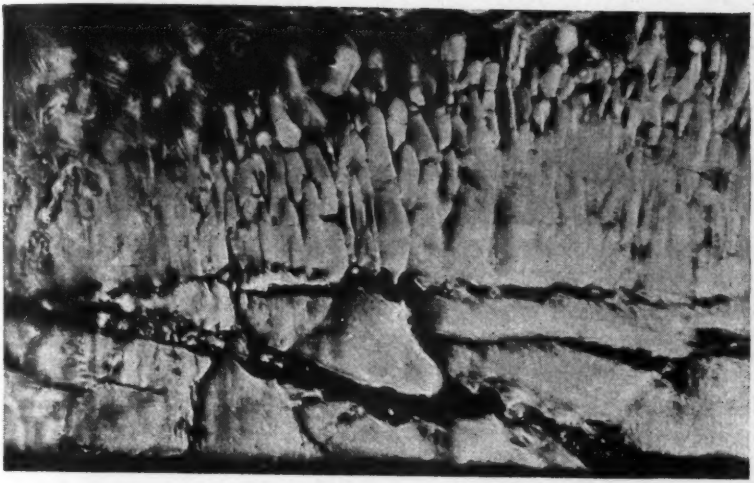
(*Slide No.* 9) This may not be visible to all of you. I just happened to run across this in one of the journals which gives an idea of the rates of diffusion or rather the direction of diffusion between various metals. The one with which we are concerned is copper and zinc. Copper has a minimum inter-atomic distance of 2.54 and zinc varies from 2.67 to 2.92— Angstrom units.

Diffusion of Elements in the Solid State — A New Aspect (La **diffusion des Éléments à l'État Solide, un Nouvel Aspect**). BINAYENDRA NATH SEN. *Comptes Rendus*, Vol. **199**, Nov. 26, 1934, pages 1189-1190. When 2 elements are in contact in the solid state, the element that penetrates the other is the one whose atoms are closest together.

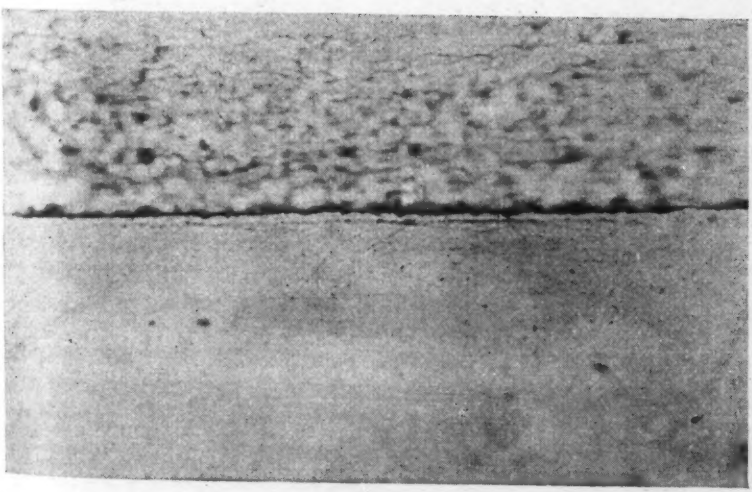
Metals	Minimum interatomic distance, cm.x10^{-8}	Direction of Diffusion
Cu-Pt	Cu 2.54 Pt 2.78	Cu penetrates Pt
Cu-Zn	Cu 2.54 Zn { 2.67 2.92	Cu penetrates Zn
Fe-Ag	Fe 2.54 Ag 2.876	Fe penetrates Ag
Au-Pb	Au 2.88 Pb. 3.48	Au penetrates Pb
Fe-C	C 1.50 Fe 2.54	C penetrates Fe

(Ed. note:—More to the point would be relative atomic size.) FHC (10)

Slide No. 9



Slide No. 11



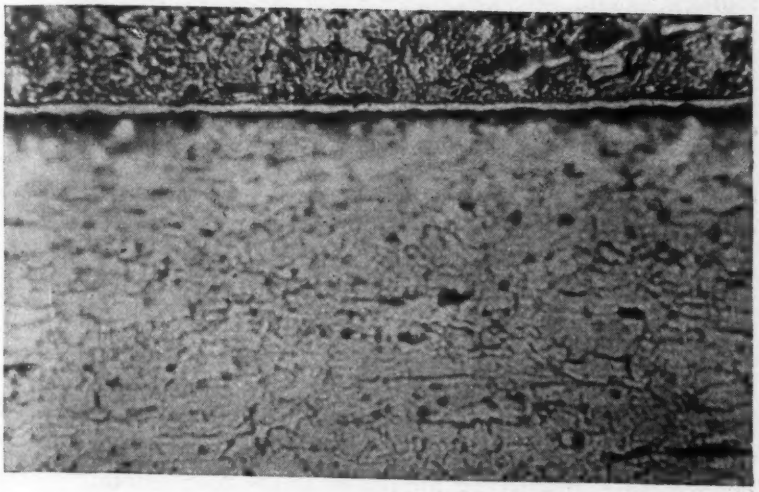
Slide No. 12

(*Slide No.* 10) To my mind, this is a beautiful picture of a hot-galvanized coating. It may not be the ideal hot-galvanized coating, but I think it is a good picture of one. This is the steel. The coating is about two mils thick. That up there is chromium and it was plated directly upon the zinc coating to enable us to polish it. This zone here is a very heavy zone of $FeZn_3$, a brittle alloy. These are $FeZn_7$ structures. Notice the cracking through the $FeZn_3$ into the $FeZn_7$, stopping at the free-zinc stage, from here to here, representing half the thickness of the zinc. This particular piece of conduit was galvanized and then wiped with ten pounds of air pressure. If we increase the air pressure, we would remove the free zinc, and we would see something similar to what we shall see in the next slide.

(*Slide No.* 11) Here is a picture of a very poor hot-galvanized coating. I do not want to have anyone get the impression it is a good zinc coating. It is not. This zone here is $FeZn_3$. Look at the cracks that go through it. Then the $FeZn_7$ zone, the zone of free zinc, is not visible. All the zinc is alloyed. This particular pipe was in the hot-galvanizing pot for twelve minutes. We put it in there purposely to study the rates of formation of the $FeZn_3$ zone. I am showing you these slides to illustrate the problem that when we get diffusion between metals and formation of brittle alloy zones, we get pronounced peeling at the very brittle alloy zone, which is represented in this case as $FeZn_3$.

(*Slide No.* 12) Now I am going to show you a few pictures of diffusion between copper and zinc. This is copper running way up in there, taken at 2,500 magnifications. Zinc is here. This is the amount of diffusion at room temperatures after three months of plating. At no time was this material subjected to a higher temperature than eighty degrees Fahrenheit. Notice you get a noticeable diffusion at room temperature.

(*Slide No.* 13) Here is one hundred-thousandths of an inch of copper that had disappeared into zinc. It did not disappear; it just changed color. The coating was there all the time and when we took a cross-section picture of it, as you see now, we



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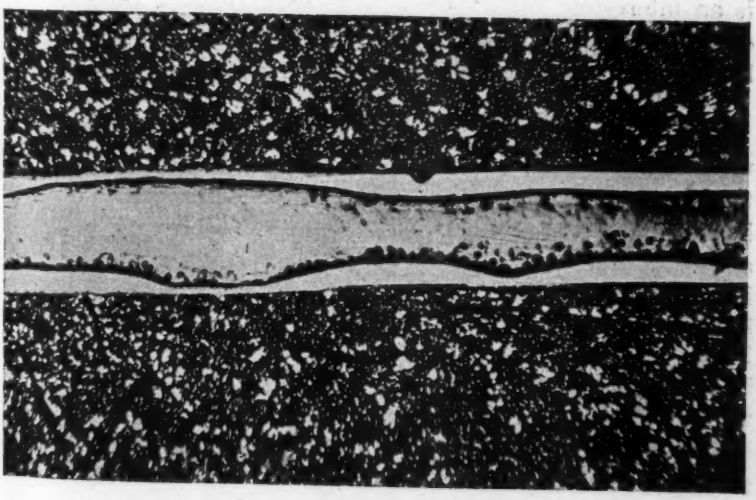


Slide No. 14

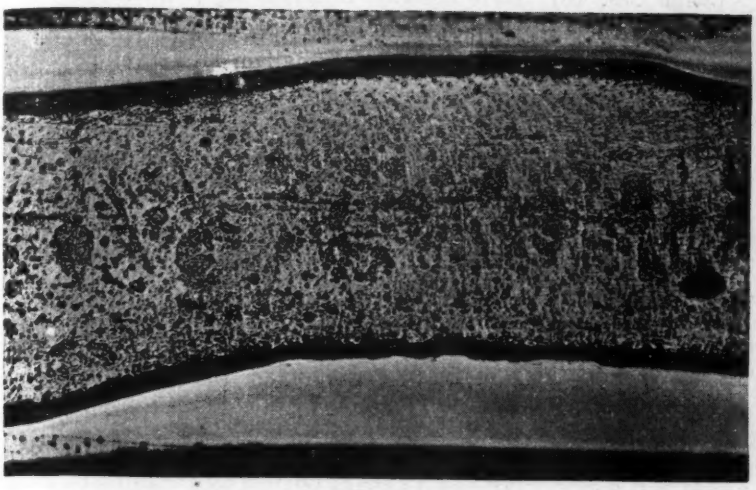
found it again. So your copper does not disappear; it goes into the zinc-copper alloys.

(*Slide No.* 14) Here is a slide to illustrate the different rates of diffusion between copper and zinc within a very small distance. Notice here the copper, the original copper — none of it is diffused into the zinc. Over here one hundred per cent is diffused into the zinc. Here part of it was diffused.

(*Slide No.* 15) This is the edge of copper with a slight diffusion here and a slight diffusion there, and probably within a thousandth of an inch we have tremendous diffusion with this very brittle zinc-copper alloy. We analyzed this alloy and found it to be sixty per cent zinc and forty per cent copper. There is probably a gradual transition of the amount of copper from here down to here, through all the phases of the zinc system. I was not successful, though, in resolving them into the various phases.

(*Slide No.* 16) Here is an excellent example to show you where the peeling takes place. This is a diffusion coating from there to there. It was flexed very slightly and then mounted and photographed. Notice the cracking down here, and here is an interesting thing: there is a crack running through the diffusion zone and stopping at the copper. The copper has a buffering effect on the cracks.

(*Slide No.* 17) Here is a very clear case of cracking of nickel on lead-antimony alloys, which is due to the cracking of the nickel itself and it is not due to the basis lead alloy. This lead-antimony alloy was copper plated and then nickel plated, and cracks developed, or we developed them ourselves, by putting it alternately in hot and cold water. I made a cross-section of it and examined the cracks. The crack ran down to the copper but it did not go completely through the copper. This picture is not very good. The observation under the microscope was much better. There is no crack extending through the copper. It went to the copper and stopped there. That could not be traceable to the basis metal, but it is traceable directly to the nickel deposit itself.



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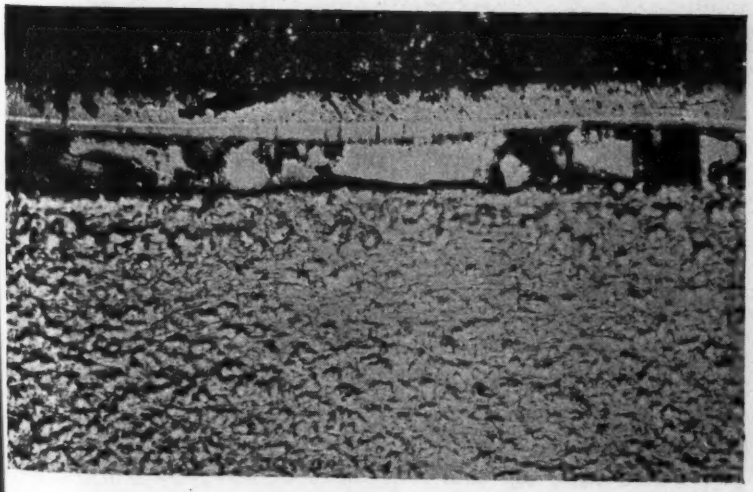


Slide No. 16

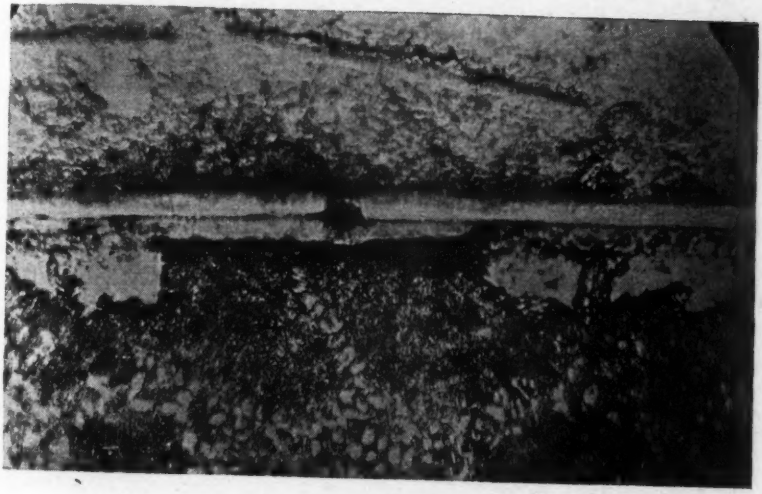
(*Slide No.* 18) Here is a case of blistering of nickel deposits. We took a sheet of lead antimony alloy, nickel plated it, chrome plated it, and then dipped the lower half in HCl to remove the chromium and subjected the entire sheet to cathodic hydrogen. The nickel and lower half had been subjected to the same stresses as the upper half. This portion is the upper half. I did not take the lower because there were no blisters visible. This is probably the most interesting thing. There is a fresh peel here. Notice the cracks ran off the nickel plate, and were transmitted to the basis metal and you can see the cracks in the lead antimony alloy.

(*Slide No.* 19) I just wanted to show this to illustrate the use of the microscope in measuring thicknesses of various zones. This does not happen to be an electrocoating. It is iron-copper-nickel and silver. We had a case of peeling and wanted to know where it was. We found out the peeling was between the copper and the nickel and not between the nickel and the silver.

(*Slide No.* 20) There is a pit. Notice these lines running up here that look like nebulae rather than a pit. Notice the bright center. Various hydrogen bubbles were here. The bubbles were sweeping upward.

(*Slide No.* 21) Here is another picture of a pit. This pit was from that cracked nickel deposit you saw a few moments ago. Notice the cracks start down in the center. The pit was probably due to some basic inclusion having a lower hydrogen voltage and if you look carefully here you can see concentric rings which seem to indicate that hydrogen bubbles formed and broke. The pit sinks as if it were counter sunk. It is not raised, as you might be led to believe. These are cracks radiating from the pit.

(*Slide No.* 22) Here is a case of interlocking in holes. This particular one happens to be a hot-dipped coating. Here was a hole in the iron, which is represented here. Notice the way it penetrated into the undercut surfaces and really formed an inter-locking deposit.



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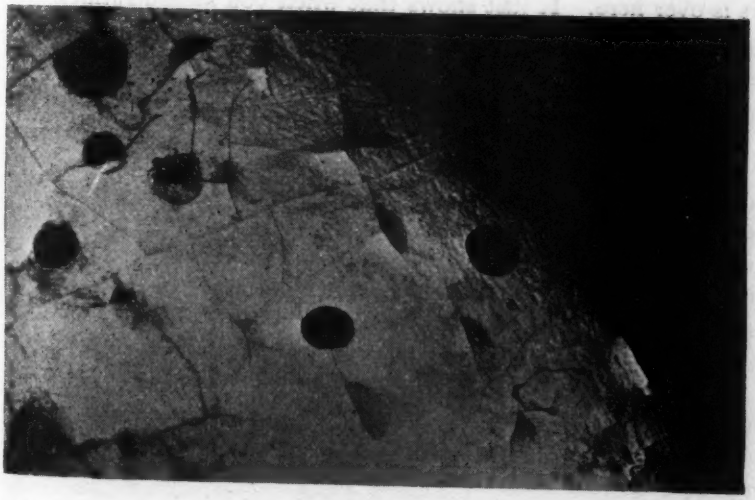


Slide No. 18

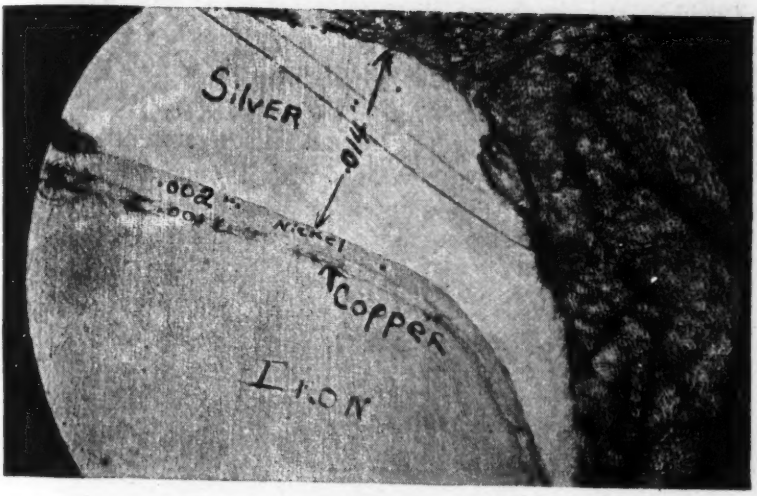
(*Slide No.* 23) Here is an odd picture of the penetration of copper and nickel in a hole or a pit on a plate. Here is the copper. It ran down in here and it did not go down in there. The nickel went away down in the hole. This little odd structure up here is due to a projection that was cut across in the polishing. Notice the copper stopped there and the nickel penetrated much better into that hole.

(*Slide No.* 24) Here is a real case of throwing power in holes and crevices. I really cannot understand it myself, but it is there, and I photographed it and that is all there is to it. Here is copper plating away down in here. It ran down into here and away off the edge of the screen. Then nickel followed. Who said that undercut crevices did not cause interlocking? You will get a better bond with undercut, rougher surfaces of this type.

(*Slide No.* 25) Here is a picture to show the variation in thickness of plate at the edge of the specimen and near the center. This was a specimen three by five inches that was cut diagonally and then you see the end of it. It is copper-nickel-brass. Notice here the plate is almost three times as thick as it is over here. It just shows that when you measure thickness with a microscope, please be careful where you measure the thickness, because you might get the wrong impression of the average thickness.

(*Slide No.* 26) This is the last slide and it is a case of super-peeling. This was brass on zinc. Someone asked at one of the previous meetings, why not brass plate instead of copper, and then you will not have the diffusion. You will not have as much as it is already there in part. Here we have the diffusion zone — brass-nickel. This was heated in an oven at 150° C. for eight hours. We took it out and took a photomicrograph. The diffusion alloy is lifted from the zinc. The brass is lifted from the diffusion alloy and the nickel is lifted from the brass. You could not want a better example of peeling. It is primarily due to lowering of ductility. This is very, very brittle here.

Now we shall turn to the last demonstration.



Slide No. 19

Slide No. 20

(*Motion picture*) We are going to show you the formation of acid at the anode and alkali at the cathode. We have two indicators, one phenolphthalein and the other nitrosine yellow. Nitrosine yellow changes its pH in the neighborhood of 6.8 This is the cathode and will turn pink on electrolysis. At the anode it turns yellow due to acid formation. These currents will distribute these solutions with various pH's throughout the body of the liquid. This is a sodium sulphate solution. We did not use HCl because we did not want to attack the anode.

Boost up the current now. In a nickel solution you have buffering agents, such as boric acid, which naturally tones down the acid and alkali formation, but I think this clearly brings out the fact that we have alkali formation at the cathode and acid formation at the anode. We seem to have a difference of pH throughout the solution. In this solution the anode efficiency is zero and the cathode efficiency is zero. Are there any questions on this solution while it is going?

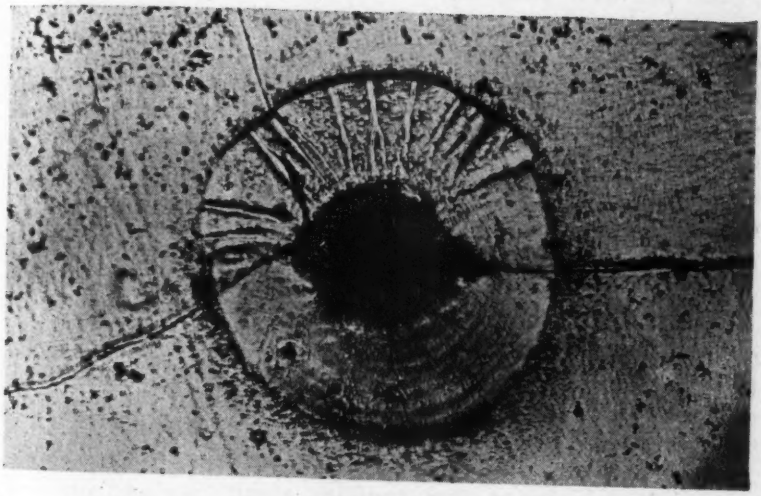
This is all acid over here now. This bounding of the solution of the hydrogen bubbles is due to the surface tension of the solution. This is the top of the solution here. The hydrogen bubbles hit it and when they hit the surface they seem to strike a stretched membrane and some of it bounds back again. I believe that will be sufficient. (Applause)

CHAIRMAN PHILLIPS: Gentlemen, a study of this kind reminds me of a saying that one of our works managers used to have. It was labeled, "The Working Fool. He went ahead and did it because he didn't know it was difficult." When you all see these difficulties that we encounter in plating, and that are really very valuable aids in finding out how to overcome them, you wonder how we ever did plate at all.

Is there any discussion on this paper?

DISCUSSION

MR. STRAUSSER: I should like to ask Mr. Meyer one question. One of these slides showed us where the copper had dissolved into the zinc, and he told us it analyzed something like sixty per cent copper and the balance zinc. What was your method in determining that composition of that analysis?



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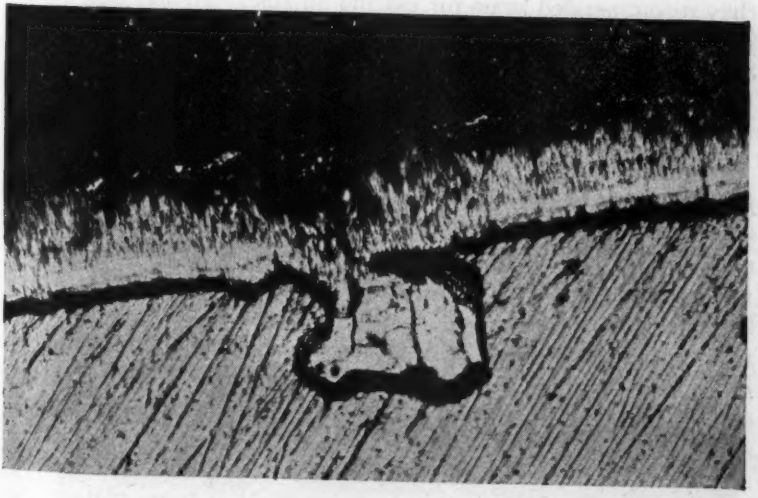


Slide No. 22

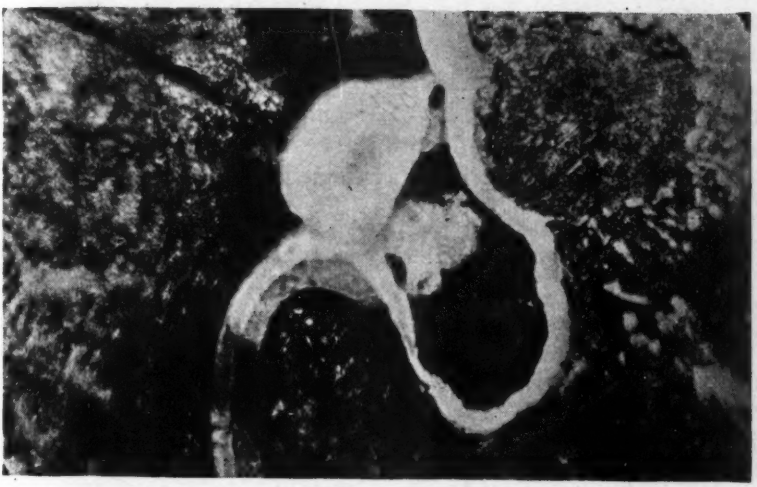
MR. MEYER: The analysis of the coating that flaked from the zinc was sixty zinc and forty copper, roughly. It is very easy to do it because that alloy is exceedingly brittle. All you have to do is bend the plate and the alloy pops off and then you can collect it. We analyzed the zinc sheet itself that was left to make sure that no copper was remaining in the zinc. The solid solubility of copper in zinc is low, anyway. It was just a question of flaking it off.

MR. W. J. SNYDER (New York): I should like to ask Mr. Meyer a question concerning one of these slides, as to how much of that brass he deposited and under what conditions and what production—where he says there are two strikes on the diffusion of brass on high zinc base metals.

MR. MEYER: This brass was deposited from what we call a normal brass solution that contains about two and one-half ounces of copper and one ounce of zinc, one and one-quarter ounces of free cyanide, five-ten-thousandths of an inch brass. As long as the work is not subjected to high temperature, you can get away with brass plating. In fact, I wrote an abstract of brass plating as an intermediary coating for the MONTHLY REVIEW on some work that was done in Germany. In that they recommended brass for plating on zinc. In any case where you have the zinc exposed to temperatures in the neighborhood of boiling water, it is better to put copper on rather than brass. I repeat again brass would be satisfactory if the temperature of the article would always be lower than the boiling point of water.

MR. SNYDER: Is all commercial work subjected to the high temperatures before it is subsequently plated with, say, nickel and chrome, or is all commercial work practically brass plated and sold as a brass deposit subjected to the high temperatures you speak of? In addition to that, perhaps Mr. Meyer would like to see some work that is done on a basis of from fifteen to twenty thousand pieces a day, going out commercially, and he might like to take that opportunity to come over and see an exhibit at the DuPont booth. We have samples there of the type of work I speak of.

MR. MEYER: I did not mean to imply that brass plating was



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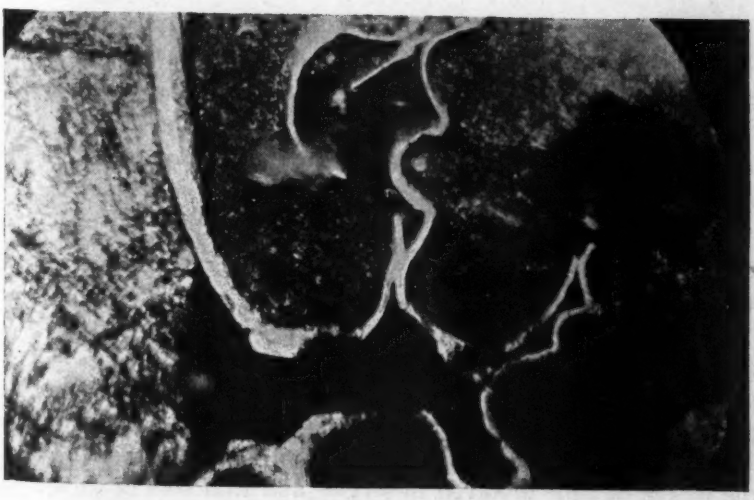


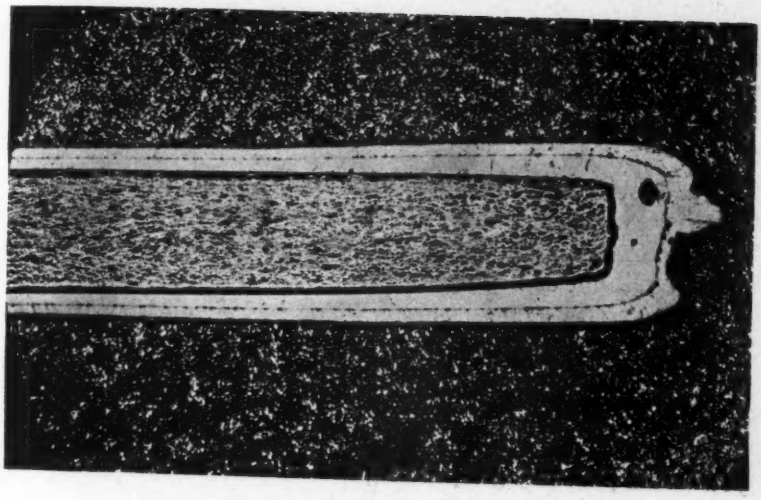
Slide No. 24

not being done on zinc. I did mean to say that I do not recommend it for plating on zinc whenever the article is to be subjected to temperatures which I have already mentioned. Just because this is being done in commercial practice does not mean necessarily it is the best practice. It is, in some cases, a very easy way to do it, and it is probably the best way where the history would be apt to be one in which high temperatures would not be considered.

CHAIRMAN PHILLIPS: Mr. Meyer, I have a question in that same connection. There is a question, of course, of both temperature and time, and I think that we, perhaps, have to carry the study a little further at lower temperatures and longer times before we are really going to get the answer. Have you done that?

MR. MEYER: I might mention this: Sometimes we think the article won't be subjected to high temperatures. We had a very interesting case where high temperature was involved right in our own processing. We plated zinc die castings and then put on a baked enamel strip and that baked enamel had to be baked at 250 to 300 degrees Fahrenheit, and right there we ran into diffusion troubles and flaking troubles. It is true there seems to be a very rapid change in the rate of diffusion from room temperature up to the temperature of boiling water. There is a difference in the rate of diffusion between the amount of cold-working, between the grain structure itself, and the composition of the alloy. In general, the diffusion is much more rapid on pure zinc than on the zinc alloys themselves. The copper does not diffuse anywhere near as rapidly as on rolled zinc or high purity zinc.

MR. A. K. GRAHAM (University of Pennsylvania, Philadelphia, Pa.): I cannot help but feel your remark was quite pertinent, and I should like to add a little emphasis to it. Is it not true the damage that might result from diffusion will be dependent upon both time and temperature? If you say you can recommend brass in order to eliminate the tendency to peel because the diffusion will not be detrimental, if the temperature is below a certain temperature, do you not have to take into consideration the length of time involved in service and that sort of thing?



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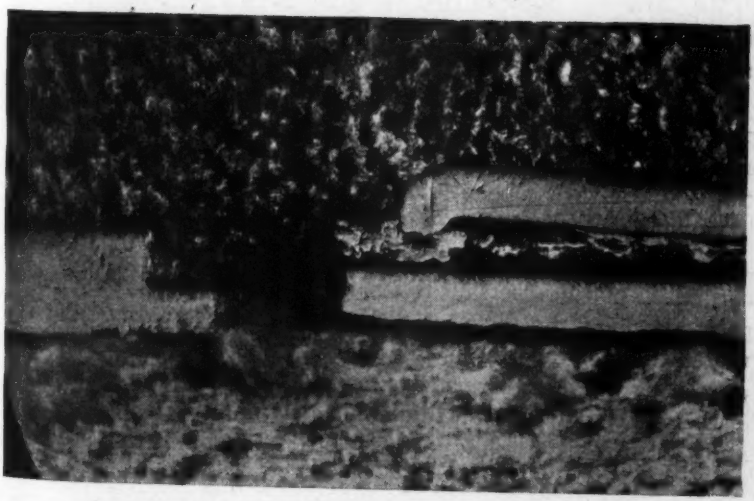

Slide No. 26

MR. MEYER: Quite right.

DR. BLUM: If I might give my idea, I think all Mr. Meyer was saying was that brass was not as good as copper for the purpose. That was the idea I got. Either one might be all right, but if brass would work, copper would work as well or better.

MR. HOGABOOM: I should like to ask you, from your experience in exposure tests, if you have observed at Key West how hot a piece of die casting gets from just the sunlight. Would it not be as hot as boiling water?

CHAIRMAN PHILLIPS: Rarely. You see, if you were to paint it black, then you would get a very high surface heat, but due to the color of the plate, you probably do not go much over 150° F.

MR. A. K. GRAHAM: If you had a black enamel on there, you would probably go quite high.

CHAIRMAN PHILLIPS: That is quite correct.

DELEGATE GEHLING: Looking at that last picture up there, showing the hydrogen gathering on the cathode rod, of course, we looked at it upside down. The hydrogen comes to the surface and bursts. What was the material that was going back down in the solution?

MR. MEYER: Some of that was hydrogen. It hits the surface and it is like a ball hitting a wall. It goes back into the solution again.

DELEGATE GEHLING: I heard Charley Proctor give us a paper at one time, saying hydrogen was the devil in the plater's solution. A thought comes to my mind: Why not load some of that solution with oxygen so it would come up and then we would have more water in there. (Laughter)

MR. F. C. MESLE: You remember that with the advent of chromium plating, we said that the chrome caused the nickel to peel. Perhaps the facts were that the chrome plating just revealed the fact that the nickel did not adhere very well. I was wondering whether these stress factors that have been mentioned in this paper may not act in a similar way. May it not be that they just simply reveal the fact that the strains that are produced by the nature of the plate, the high current density, or the heating, may simply bring out the fact that the base metal

may not have been perfectly prepared for an adherent deposit, and those strains are responsible for the peeling rather than the metals or the strain factors themselves?

MR. MEYER: I should like to answer Mr. Mesle with a specific case. I do not like to anticipate our paper tomorrow, "The Plating on Antimonial Lead Alloys", but we found that you could etch the metal sufficiently to bring out a perfect crystalline structure and still you would get the peeling and cracking. To try to bring it out, you have the actual tensile strength relationships of the metal, and the adhesion cannot be greater than the tensile strength forces of the metals concerned. On some of the metals, particularly, these stresses are greater than you might say the tensile strength, but it has low ductility, so you really do not get the true tensile strength available of the cold-worked metal.

MR. HOGABOOM: I think Mr. Meyer should be greatly congratulated for this fine work. If this had been presented about ten years ago we would have been so thoroughly mystified we would not have understood anything. Fortunately, we have a slight comprehension of what is going on in the plating solution and in the basis metal, and this is a start of a work that is of vital importance, especially if standard specifications are to be had. It shows the importance of studying the basis metal as well as the conditions surrounding electroplating. Mr. Meyer certainly has shown this to a marked degree and is to be highly complimented for such conclusive evidence. (Applause)

NOTICE

Papers for the Educational Sessions A. E. S. 1936 Convention must be received before April 1, 1936.

J. S. NACHTMAN
Chairman Educational Committee
427 Central Parkway
WARREN, OHIO

People At Work

By EDWARD H. TINGLEY
Secretary
National Association of Foremen

THIRTY years ago I attended a meeting where a phrenologist read the characteristics of people by the bumps on their heads. And it seemed that he was able to determine many things which were true. Then along came Katherine Blackford who judged people by the shape of the face and nose and the texture of the skin. And she seemed to be able to pick people according to types.

But we are today interested in classifying people according to how they work—how they get along with others. Most of us put in a third or more of our daily 24 hours at work, where to be successful, we must get along with a great variety of people. In the main we find two types:

Those who work well with others, and
Those who do not.

All of us have probably made this classification ourselves and daily see examples of such people in our own shop. Here is a test to judge which side we are on. If there are a few people with whom you cannot get along with smoothly, it may be their fault; but if there are many people with whom you cannot work agreeably, it is always your fault. Our natural egotism prompts us to think it is the other fellow's fault—but many times it is our own.

And another check is—are people enthused when you come around or are they depressed? Do things speed up when you come on the scene or do they slow down? Do you stimulate or depress the crowd? In this definition you can see the optimist and the pessimist—probably both are needed in the world but the optimist gets the most work out of people. A factory must have a conservative fellow—who holds back the wild ideas and hastily considered plans proposed—but why can't he do it in a cordial manner which does not put a "wet blanket" on the enthusiasm of the others? This whole question of working with each other and getting people to want to work, is a tremendous subject. It requires the best efforts of the executive and is the basis on which he stands or falls.

Listen to Alfred P. Sloan, President of General Motors, who says:

> "The human problem is far more delicate and difficult to handle than any production problem or distribution problem, or engineering problem or financial problem. Psychology and personality constitute at least 50% of the material requisite for success as an executive. I have seen men with fine minds who failed to make their plans effective, because they lacked understanding of how to work with people. In our business I should say that this psychological ability and personality mean 75% of the necessary equipment. The ability to get people to work together is of the greatest importance."

In every organization we find men who have the much-envied ability to get along with people, who always work well with others. Much credit is due these folks and they will progress far. But we want to discuss the other type—those who have trouble getting along agreeably with their fellow workers. It may be that we will get some pointers on how to help these persons overcome the things that are handicapping them in their work. Here are the six characteristics that cause the trouble:

First: A bad disposition.
Second: Talking too much.
Third: Finding fault.
Fourth: Egotism.
Fifth: Working on the wrong job.
Sixth: Laziness.

A BAD DISPOSITION

This is a most common fault, with some people having it worse than others. Such a man is disagreeable, irritable, sarcastic, over sensitive, easily upset. You never know what kind of an answer you are going to get; in fact you never know if it is safe to ask him anything. All day long he is in an argument with somebody and upsets the whole organization.

Many times he is a smart fellow and his knowledge of the product is valuable. But as soon as he comes in contact with others he somehow sets up a friction which retards the work of the shop. Such a fellow should be kept out of the executive

class—put him in a room by himself and use him for consulting purposes only.

Visiting a large factory where I formerly was employed, I met an old friend in the cafeteria for lunch. In the conversation I asked about a number of foremen I knew and to one question the answer was: "No, he is no longer a foreman, he is now a clerk in the Receiving Department. His bad disposition cost him his job. Nobody could get along with him." And we fell to discussing the responsibility of the management to so train the foremen under their direction, that they will not have bad dispositions. Certainly, friendly counsel by the boss will help any foreman correct his weak points.

Occasionally we find a man who becomes disagreeable because he cannot have his own way. He makes suggestions and has plans that look good to him, but because of his methods he cannot "sell" them to the others. The more he is refused the more sour he becomes and is soon deeply pessimistic. If he would only learn that he could get more things done by being pleasant and agreeable, he would see the fallacy of his ways. C. F. Kettering once said, "The greatest endurance contest is to get a new idea into a factory." It does not pay to ruin our disposition because we cannot get everyone to see things as we do.

TALKING TOO MUCH

Old Ben Franklin, in his sayings, continually admonishes us to hold our tongues, keep our peace etc. Apparently in his day as well as the present, people got into trouble talking too much. And how fast these rumors and idle remarks will travel through the shop! Many times they are only half the truth and do no good to pass along.

And be sure you do not talk too much when you are angry. We all are tempted to say things and then regret them as soon as said. It would be far better, when an executive is angry, to put on his hat and take a walk out-doors to cool off. It would save many a sorry situation where two men are saying disagreeable things because they are temporarily angry.

What of this thing you hear about another which is not a credit to him? Gossip they call it. When you hear such reports square them with the following three standards:

First: Is it kind?
Second: Is it true?
Third: Is it necessary?

Many men get the title of "agitator" because they pass on a lot of gossip they never take time to check for its truth. These men have a hard time to secure a job. What we need in every shop, is someone to pass on all the good things the management does, or the worker performs. Let's be agreeable and helpful.

Now what are we going to do about those folks who talk directly about us? Perhaps we would never have heard it if it had not been for a "good friend" who brought it to us. Are we going to let it upset us, to make us angry at the fellow who started the story about us? It is always difficult for me to know who is the worst in an organization—the fellow who invents a tale or the one who carries it around. So we should be careful we are not a "good friend" to someone else and carry news to him which ruins his day and his work.

There is another type, and he is not a gossip at all, that talks too much in general. He never gives anyone else a chance to say anything and his danger is that he will never be able to get the viewpoint of other people. Men of this type must learn this—if they are going to be smarter and know more, it will be by talking less and listening more. The first sign of an open mind is that you love to listen.

"A great talker never wants for enemies," say the Chinese.

FINDING FAULT

What about the fault-finders? In any organization they are very harmful. And the worst of it is that most of the things they find fault with are too trifling to notice. Those who constantly annoy us with irritating trifles, certainly break the spirit of an individual or a group. The fault-finders see only poor work—never the good. They remember the mistakes and not the many good things people have done. They see only the dark—never the light.

The chronic fault-finder many times finds himself condemning people and this always acts as a blight on both himself and those whom he condemns. It's confidence that builds an organization and not nagging criticism. Dr. Harry Emerson Fosdick says:

"No man can practice cynicism on everybody else long before it begins to turn in upon himself. It's a disease, which, if a man plays with outwardly, he is bound to catch inwardly. Cynicism is a fatal blight—it kills joy; it stops life."

If any of us amounts to anything, it is because there were people who had faith in us. Such faith is creative. Cynicism and faith are real forces. They effectually accomplish things in this world."

EGOTISM

Just what is egotism? It's a kind of a highbrow pride that makes us think that we are a lot more important than we really are. It usually takes on the form of knowing a lot about everything. We usually say: "He thinks he knows it all, you can't tell him anything."

This egotism is one of the real signs of a closed mind. An egotist is satisfied with what he knows, although Charles F. Kettering says: "The moment you are satisfied, the concrete has begun to set in your head." He is so satisfied that he never wants help from anyone else. He would rather prove himself right than learn a better way to do it. Hence he does not welcome help from others. There is no better test of a man than to see how he welcomes help. Remember that slogan:

He who helps me most, tells me when I am wrong.

Mr. Sloan, President of General Motors, in an interview said: "All of us have some weakness. But most human beings do not like to admit, even to themselves, that they have human weaknesses and limitations. Therefore it is often extremely difficult to get a man in the frame of mind where he will gladly seek to gather from other people in the organization what would offset, what would remedy his weakness. Yet this must be done in an organization about a maximum of efficiency and effectiveness."

WORKING ON THE WRONG JOB

Now who is the right man for a job? Henry Ford once answered this question by quickly asking another: Who shall sing tenor in the quartette? The tenor of course. But it is not so easy to pick the right man for the job in a factory as it is to choose between the tenor and bass. There are dozens of types of people and dozens of types of skills required for industrial work. But in many cases, the executive is able to see

that some fellow is striving to hold a job for which he is not fitted and in his striving causes friction and delays to the rest of the men. He is ambitious to make good but the requirements of the job just require a different temperament. A salesman talked to me today and said he was tired of selling insurance, it was so intangible—he wanted to do something with his hands. Apparently every organization has its misfits.

But how long shall we let this condition go on? Shall we let young men stay on jobs they do not like until they are ready for a promotion and then tell them they are not fitted for that better job? Especially as a man gets older, no one wants to tell him he is on the wrong job. We feel that we would "break his spirit," if we demoted him. But what do we do? We discharge him, and what do you think that does to his spirit?

Of this we are sure—everyone wants to be on the job he can do best. We want to work on the kind of work that we have a talent for—that gives us that inward satisfaction of accomplishment. And we want to work under the boss who helps us find that job and encourages us to learn more about it and grow on it. Probably we can help the other fellow to find the work he is best fitted for, if we will study the problem in our own factory.

LAZINESS

The modern factory is no place for the lazy man. He has a hard time finding a job where he can "kill" much time these days, with wage incentive plans, conveyors and high speed machinery. But maybe the lazy man might be found in the office where there is no conveyor bringing his work to him. Many times it is hard to measure office work so it is up to the man himself to turn out a good day's work. Elbert Hubbard once said:

"Lazy men are just as useless as dead ones and take up a lot more room."

The lazy man is to be pitied for he will be in trouble anywhere he goes. The natural thing to do is to work. Prosperity and happiness comes only through honest effort. America's development came from the hard work of the pioneers, and our industries of today were built on long years of struggle. So if we are going to succeed we must work and do our share, for the fellow who will not carry his part of the load will always be out of balance.

Adventures in **Electroplating Copper** *from Ammoniacal Solutions*

By E. A. VUILLEUMIER

Read at Bridgeport 1935 Convention

THIS paper, first of all, will contain little that is of direct value to the expert electroplater, since it deals largely with deposits that consist of a spongy mass of large, loose crystals. Such deposits, of course, the skilled platers of this Society rarely get to see. We amateurs, however, must confess to meeting them frequently and to finding them of greater interest than the dense, smooth, adherent platings which gladden the heart of the expert.

Perhaps it is making a virtue of necessity, but our motto is "The worse the deposit, the better we like it." This applies, of course, only to such work as we do in our own laboratory. When we want good work, we have sufficient judgment to call on the professional plater. It is, therefore, unlikely that you men will need to fear the competition of the college professor electroplater.

However, we rural professors, at least, feel almost indecently flattered when we get an invitation to read a paper at one of your conventions. And, strange as it may seem, we like to think that you men who do such excellent work can perhaps profit from our adventures with deposits that are burnt, peel, crack, or are spongy.

This paper deals with an adventure which began at Berne, Switzerland, in 1917, was continued at Dickinson College and in Professor Bancroft's laboratory at Cornell, and the end is not yet. A brief report was printed in The Journal of Physical Chemistry for May, 1932, and the following discourse is taken largely from this article.

When copper is plated from an ammoniacal cupric solution, the deposit obtained is relatively dense, smooth and adherent. The author observed, however, that when the electrolyte had been in contact with metallic copper for a few hours prior to the

electrolysis, there was a striking change in the nature of the deposit to be obtained. It then consisted of a dull red, thick, moss-like, coarse, non-adherent mass, which under a low power microscope was seen to consist of relatively large, bright copper crystals. It was also observed that upon the addition of concentrated ammonia or ammonium sulphate (but not sodium sulphate) or by thorough oxidation by aeration of the partially reduced electrolyte, good results, i.e., dense, smooth, adherent deposits were again obtainable.

The present investigation indicates that a cuprous oxide cathode film is responsible for the unsatisfactory deposit; that an electrolyte from which an unsatisfactory deposit is obtained is one which does not dissolve cuprous oxide.

It was found that cuprous oxide is readily dissolved by concentrated ammonia water, or by ammonium sulphate in the presence of diluted ammonia water. Furthermore, it was found that an ammoniacal cupric solution could be decolorized by metallic copper only upon adding concentrated ammonia or ammonium sulphate.

Concentrated ammonia water or ammonium sulphate in the presence of diluted ammonia water evidently prevents the coating of metallic copper by a film of cuprous oxide, or dissolves the film if formed. Such a film would explain the incomplete reduction of the cupric solution, and, forming on the cathode, would, where broken through, give rise to a mass of relatively large, non-adherent crystals.

A stock solution was prepared by dissolving 25 grams of the pentahydrate of cupric sulphate and 60 cc. of concentrated ammonia water in sufficient water to make a liter of solution. A 100 cc. portion of this solution was electrolyzed for 20 minutes at a current density of 6 milliamperes per square centimeter, using copper electrodes. A dense, bright, adherent, relatively smooth and therefore good deposit was obtained. The electrolysis was discontinued, but the electrodes were allowed to remain in the bath over night. The electrodes were then replaced by fresh ones. The solution was again electrolyzed, and after twenty minutes a coarse, non-adherent mass was observed. A good, fresh electrolyte was also converted into a bad one by allowing a strip of copper to stand in it for three hours, or by

adding a centigram of cuprous oxide. The addition of two grams of ammonium sulphate, or of an excess of concentrated ammonia, to the unsatisfactory bath, resulted in a good deposit.

Several attempts were made to decolorize the slightly ammoniacal stock electrolyte by means of copper in the absence of air. The solution, however, remained dark blue indefinitely. But upon adding concentrated ammonia or ammonium sulphate to the solution, it was promptly decolorized by the metallic copper.

If a film of cuprous oxide is responsible for the bad deposits, and for making it impossible to decolorize the stock solution by means of copper, it was to be expected that cuprous oxide would be dissolved by concentrated ammonia water, or by ammonium sulphate, but not by diluted ammonia. It was found that the oxide was readily dissolved in concentrated ammonia water. Diluted ammonia water or ammonium sulphate, separately, were found to be without effect. But when ammonium sulphate was added to a slightly ammoniacal suspension of cuprous oxide, the liquid rapidly became clear and colorless.

SUMMARY

1. By electrolyzing a cupric ammonia complex, a relatively dense, smooth, adherent, i. e. good deposit, is obtained.

2. If metallic copper or cuprous oxide is dissolved in the ammoniacal cupric solution, the deposit obtained consists of a thick, coarse, non-adherent mass of relatively large copper crystals.

3. The addition of concentrated ammonia water, or of ammonium sulphate to this now unsatisfactory electrolyte, results in a good deposit upon further electrolysis.

4. A cuprous oxide film on the cathode is apparently responsible for the unsatisfactory deposit. Where this film is broken there grow loose crystals of copper.

5. An electrolyte from which an unsatisfactory deposit is obtained is one which does not dissolve cuprous oxide.

6. Cuprous oxide is dissolved by concentrated ammonia or by ammonium sulphate in the presence of a small amount of ammonia.

7. The cuprous oxide film formed on copper added to a slightly ammoniacal cupric solution prevents the decolorization of the solution. The addition of concentrated ammonia or of ammonium sulphate dissolves the oxide, and the solution is decolorized. (Applause)

DELEGATE PROCTOR: I was reminded of twenty-five years ago, when Mr. Hogaboom spoke about what a practical man can do. There was a patent then, which prevented our using aluminum sulphate, so I started to use common alum dissolved in hot water, and by adding that solution I formed aluminum sulphate. I have done considerable work with sulphates. In fact, you probably remember many years ago when I first wrote about red copper compound. Red copper compound was a copper sulphide that came from Germany. Later on I became interested in the metal cyanides and introduced the metal cyanides in the United States. I dropped copper sulphate, but it is a big factor. We shall probably learn more about that eventually.

There is no question in my mind if we get down to a copper sulphate solution and can add sufficient ammonium sulphate solution, that we may be able to get a copper solution that might possibly equal the cyanide solutions for a great many purposes, and I express my appreciation to the doctor for the work he has been doing, because it follows out some of the work I did years ago. I sometimes wish that I had been able to graduate from a university. I started in Birmingham, England, at Middle Institute to take up electricity and electrochemistry, and that is what makes me such a great traveler today.

MR. HOGABOOM: I assure you that I am going to keep away from copper solutions, especially from controversies that would arise were I to enter into discussions with Dr. Vuilleumier because we might get into discussions so deep that we would have to split hairs.

In reading Dr. Vuilleumier's paper, which I had the pleasure of doing some time ago, it was interestingly noted that he collected some oxygen at the cathode. Probably a complex salt is carried over and then is discharged or decomposed and oxygen is given off. At the same time there was a paper from England, by Hothersall, upon the addition of nitric acid and hydrogen peroxide to the solution, and they collected oxygen at

the cathode, also. That is so contrary to all our experiences that I wonder if Dr. Vuilleumier will tell us how he collected oxygen at the cathode and, if possible, the reaction.

DR. VUILLEUMIER: Mr. Hogaboom, I shall be very glad to try to answer the first part of that question. I am going to refer the second part to Dr. Blum. There was no oxygen liberated in my case at the cathode. There was a certain amount of cuprous oxide. I know, of course, that oxidation is associated with the anode rather than with the cathode, but, as you know, colloidal particles bear an electrical charge. Some of them are positively charged and some of them are negatively charged. The cuprous oxide, we have reason to believe, despite the fact that it contains oxygen (forget about that for a moment), is a colloidal particle. The cuprous oxide is there in the colloidal state. This particular colloid moves toward the cathode as some of the oxides do. I shall now refer the second part of the question to Dr. Blum.

DR. BLUM: I am going to tell you a story. I know some of you have heard it, but it is so appropriate. You remember the story of the club where each week a member was permitted to ask any question he wished with the proviso that he must know the answer and be able to answer it if the others could not.

In this particular case the man selected asked this question: "Why is it that when a squirrel digs a hole in the ground he does not leave any dirt around the top?"

After he passed around and everybody had given up, it came back to him, and according to the code it was necessary for him to answer; and he said, "That is perfectly simple. The squirrel begins at the bottom." Then, of course, one of the members spoke up immediately and said, "How does he get to the bottom to start to dig?"

The man said, "Well, that is your question."
(Laughter)

Mr. Hogaboom has referred to two things which are entirely distinct here. The first one has been referred to by Dr. Vuilleumier. There is no anomaly in the fact that a deposit at the cathode may contain oxygen in the form of oxides, hydroxides, or basic materials. In fact, that, I think, is the best explanation of a burnt deposit. It is a deposit that contains some basic material, such as oxide or hydroxide. In fact, in the

discussion of nickel deposits, including those described by Dr. Casper and myself, it was pointed out by Macnaughton and Hothersoll and others that brittle nickel deposits are almost certainly associated with the presence of included hydroxide rather than, as previously supposed, included hydrogen. So at least we know every time you make a burnt deposit you can get oxide in the deposit, and that does not represent an oxidizing condition but simply a change in the acidity of the solution at the cathode that causes hydrolysis and permits the hydroxides to be produced and included.

The other case that was referred to, of actually liberating oxygen at the cathode when you have hydrogen peroxide especially present in a nickel plating bath, I think can be explained also not on electrochemical but on chemical grounds, that is, that you have them at the cathode not simply the reduction of hydrogen peroxide, which normally takes place and which probably accounts for the value of hydrogen peroxide in preventing pitting, but you also have a tendency for hydrogen peroxide to decompose, as it does on any surface, and especially on a surface that may contain certain impurities, so that in one case, if you get oxygen given off, it is probably the same as would be given off even if no current was passing, simply the fact that the hydrogen peroxide in contact with that particular surface has a tendency to decompose and give off oxygen. That, at least, is as far as I would attempt to go. If any of you want to start at the bottom, you can do it. (Applause)

MR. HOGABOOM: Probably it would be interesting to tell the story of Dr. Bancroft. Dr. Vuilleumier spoke of Dr. Bancroft and what he said was very interesting. Dr. Bancroft was experimenting with a copper sulphate solution, and made an addition of his colloid to it, and left his anode in over night, and it came out a beautiful purple. He thought he had discovered something very fine. It was a rather peacock blue. So he duplicated the test and got his purple again. Then he made several samples and wrapped them up carefully. They had the International Congress of Chemistry at St. Louis, and Dr. Bancroft got up and began to tell his story. Then he unwrapped the samples but, as every plater knows, they had faded and there was no more purple. There was no more of the peacock blue on the surface.

That is an interesting story along with copper sulphate and Dr. Bancroft.

MR. CALDWELL: I want to ask a question. At any time when producing these deposits, did you get any deposit that was colored, that could be used for decorative etches?

DR. VUILLEUMEIR: The possible use to which this copper might be put occurred to me yesterday. It never occurred to me that this copper might have any practical value, but if there is any use for fine crystals of copper, if they can be used in a decorative way, I think you have here a very easy way to make small-fine crystals of metallic copper as a coating. From the viewpoint of electroplating it is a terrible flop.

METALLGRAPHIC POLISHER

As a companion piece to the Bausch & Lomb Electroplater's Microscope, the H-V W-M Metallgraphic Polisher has been developed recently by the Hanson-Van Winkle-Munning Co. of Matawan, New Jersey to be used for preparing a specimen for the measurement of plate thickness.

The Polisher consists of a surface grinder with two fabric covered wet polishing disks mounted on the same chassis. The surface grinder may be operated in a horizontal or vertical position and carries a 4 x 36 inch belt, set up with metallgraphic emery. Adjustments are provided to insure proper tension and tracking of the belt.

The wet polishing disks are mounted vertically on either side of the driving shaft and are encased in adjustable cast aluminum splash guards. The polishing cloths are held in place by a spring which fits into a groove in the periphery of the disks thus insuring even tension and perfect balancing of the disks. A removable pan is placed under the splash guards to collect excess polishing suspension. A 1/3 H.P. 1750 RPM motor is recommended to drive the machine.

To prepare a specimen, suitable sections are sawed from the plated article and mounted on a clamp that is provided with the outfit. Filing with a coarse file and then a #2 Pillar file produces a surface that is sufficiently even for polishing. The specimen is first ground on the dry fine emery belt and then on the first disk covered with duck. A very fine metallgraphic emery suspension in water is applied to the disk with a camel hair brush during this operation. The final polishing is carried out on a disk covered with broadcloth to which a suspension of levigated alumnia is applied. After washing, drying and in most cases etching, the specimen is ready for examination under the microscope. The preparation of a specimen which may contain up to 24 sections requires 30 to 60 minutes.

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The Effect of **Sodium Fluoride** *on the Bright Plating Range of Chromium in a Chromic Acid Plating Bath**

By E. CURSCHMANN and H. HEINRICH

MANY substances have been suggested to take the place of sulfuric acid in a chromic acid plating bath. Among the most promising, are hydrofluoric acid, sodium and potassium fluorides. Although all three are better than sulfuric acid as addition agents, sodium fluoride possesses the commercial advantages of being cheap and easily handled.

The addition of eight grams of sodium fluoride per liter (0.974 oz/gallon) instead of the customary amount of sulfuric acid gives at 45° C. (113° F.) a bright plating range from 1 to 3.75 amperes per square inch which is about three times that of the sulfate bath. The average current efficiency for this plating range is about 19% against 13% for the sulfate solution.

APPARATUS AND PROCEDURE

The plating bath used in the following series of experiments consists of a rectangular glass jar (4x4x8 inches) with a wooden cover, waxed to protect it from the attack of the chromic acid spray. The polished copper cathode (1x2 inches) was fitted into the wooden cover in such a manner as to suspend it in exactly the same position each time in relation to its distance from the two anodes on either side and the bottom of the vessel.

The following three precautions were necessary in order to obtain satisfactory and reproducible results:—

*A contribution from the research laboratories of Marquette University, Milwaukee, Wisconsin

1. A preheating of the copper test pieces in an air bath to the temperature of the electrolyte prevents the laying down of a coarse structure.

2. A low initial amperage prevents the burning of the lower edges of the cathode. Immediately after the complete immersion of the cathode the amperage is raised to the desired value.

3. Rounded corners prevent excessive burning at the edges.

This procedure gives a wider bright plating range for either the sulfate bath or the sodium fluoride bath; but since all test pieces in this series were treated alike, the results are strictly comparable.

The temperature of the plating bath was kept constant by having the plating jar in a large tin container filled with water at the proper temperature. The time of plating was always five minutes.

RESULTS

The plates obtained from the fluoride baths were compared with those obtained from the standard sulfate bath as to the appearance of the deposit and the extent of the respective plating ranges. The following results were noted:—

1. The plates from both types of solutions possess the brilliant blue luster characteristic of chromium deposits.

2. A solution containing eight grams of sodium fluoride per liter (0.974 oz/gallon) at 45° C. (113° F.), is recommended. The bright plating range of this bath is considerably wider than that of the sulfate bath. Bright uniform deposits can be obtained over a wide range of current densities, slight burning of the edges taking place only after the current density has been increased to four amperes per square inch.

Table 1 summarizes the results of about one hundred and fifty test pieces. Concentrations of sodium fluoride between six and ten grams per liter produce the brightest and most uniform deposits. Satisfactory plating conditions are represented by the shaded portion of the graph.

TABLE I

The Bright Plating Range of the Flouride Bath Containing Various Amounts of Sodium Fluoride

Temperature: 45° C. (113° F). Time of Plating: 5 min.
Cathode: Polished Copper. Anode: Antimoniated Lead.
Electrolyte: 250 grams of CrO_3 per liter (30.4 oz/gal.)

Grams of Sod. Fluoride per Liter	Lowest Current Density at which a Bright Plate was obtained (amps/sq. inch)	Highest Current Density at which a Bright Plate was obtained (amps/sq. inch)	Plating Range (amps/sq. inch)
5	1.00	1.25	0.25
6	1.00	2.25	1.25
7	1.00	3.25	2.25
8	1.00	3.75	2.75
9	1.00	3.25	2.25
10	1.00	2.25	1.25
12	1.00	1.75	0.75
14	1.00	1.50	0.50
16	1.25	1.50	0.25

The addition of less than five grams of sodium fluoride to the electrolyte produces frosty deposits.

TABLE IA

The Bright Plating Range of the Sulfate Bath.

Conditions: Same as above.

Grams of Sulfuric Acid per Liter	Lowest Current Density at which a Bright Plate was obtained (amps/sq. inch)	Highest Current Density at which a Bright Plate was obtained (amps/sq. inch)	Plating Range (amps/sq. inch)
1.5	0.50	1.50	1.00
2.7	0.75	1.50	0.75

The highest cathode efficiency (almost 24%) is obtained at a temperature of 35° C. However, the bright plating range is only 0.5 ampere per square inch. No chromium was deposited in the center of the test piece below a current density of 1.25 amperes per square inch. The plates became frosted at 1.75 amperes per square inch, above which point the burning rapidly increased.

At a temperature of 45° C. the current efficiency is lower than at 35° C., but the brightest plates and the greatest plating range, are obtained at this temperature. The efficiency gradually rises to a value of approximately twenty per cent.

The current efficiencies at 55° C. are the lowest of the three temperatures. The plating range at this temperature is 1.5 amperes per square inch. In other words, the range at 55° C. is intermediate between the 35 and 45 degree ranges. Above a

current density of 2.5 amperes per square inch. the plates no longer possess the deep blue lustre characteristic of chromium but assume a dull gray appearance with black edges.

The wide plating range of the proposed sodium fluoride bath warrants a commercial trial.

COMMITTEE RESIGNATIONS AND APPOINTMENTS

On Feb. 1, 1936, Mr. Joseph Sexton, Sargent Company, New Haven, Connecticut, succeeded Mr. Walter Fraine as Secretary-Treasurer of the Research Committee. We assure Mr. Sexton that he may count on the active cooperation of all members of the Committee and the Society.

The resignation of Mr. Fraine was accepted only because personal and business affairs prevented him from continuing to hold that office. Fortunately, he has consented to continue as a member of the Research Committee where his advice and assistance will be highly valued.

Mr. Fraine served as Secretary-Treasurer of this Committee since September 1931, and served most faithfully during his term of office, which included very trying times, such as the closing of the bank with the funds of the committee, and the business depression, which retarded the collection of funds from manufacturers. Throughout these years he maintained his unfailing faithfulness, cooperativeness and good nature. It is to the unselfish service of such men as Walter Fraine that the Society owes its progress and development. In expressing thanks to him, I know that I speak for the entire membership of the Electro-Platers' Society.

The following members will serve as a committee to report at the next annual meeting on future exhibits: Mr. W. J. R. Kennedy Chairman, Mr. E. Steen Thompson, Mr. George Gehling, Mr. T. H. Chamberlain and Mr. H. M. Cherry.

T. S. SLATTERY.

The Abstract Section

PATRICK J. SHEEHAN, *Chairman, Program and Educational Committee*

The Electrodeposition of Bronze using Bronze Anodes, S. BAIER and D. J. MACNAUGHTAN. *Jour. Electrodepositors' Tech. Soc.* (preprint) **10,** (1935-36)—Bronze deposits containing about 12 percent of tin and 88 percent of copper were produced with anodes of the same composition in a bath containing 3.5 oz/gal of copper (introduced as sodium copper cyanide), 2.3 oz/gal of tin (introduced as sodium stannate) and 2 oz/gal of free sodium cyanide. The bath was kept at 140° F. The cathode efficiency decreased from 90 to 50 percent as the current density was increased from 10 to 40 amp/ft.^{2} The anode efficiency was over 90 percent up to about 50 amp/ft.^{2}, when it dropped rapidly, because the anode became coated with a brown film. The metal content of the bath can be kept about constant by using successively large and small anodes, with corresponding changes in the current density and anode efficiency.

Thin bronze deposits on steel were found to be less porous than nickel deposits of the same thickness, and were satisfactory for subsequent chromium plating. The throwing power of the bath is very high and the deposits are about as hard as nickel deposits. W. BLUM.

The Electrodeposition of Bronze using Bi-Metallic Anodes, C. BECHARD. *Jour. Electrodepositors' Tech.Soc.* (preprint) **10,** (1935-36)—Efforts to control the metal content and ratio in acid oxalate baths by means of copper, tin, and carbon anodes connected to separate circuits were unsuccessful. More promising results were obtained by this procedure in alkaline baths contalning potassium stannate and potassium copper cyanide, but the detailed conditions for continuous deposition of any given alloy have not yet been defined. W. BLUM.

The Effect of Oxidizing Agents on Nickel Deposition. II. CHROMIC ACID, A. W. HOTHERSALL and R. A. F. HAMMOND, *Trans. Faraday Soc.* **31,** 1574 (1935)—Several years ago it was shown that very small amounts of chromic acid in a nickel bath reduce the cathode efficiency and produce poor nickel deposits. This study was conducted to explain this behavior and to compare it with the effects of hydrogen peroxide and nitrates, which are added to nickel baths to stop pitting. Increasing concentrations of chromic acid in nickel baths first decrease the cathode efficiency, then produce very bright nickel, and finally stop nickel deposition. The effect is more marked at high than at low pH. An appreciable content of chromic acid increases the hydrogen evolution and does not stop pitting. The amount of chromic acid reduced was much less than corresponded to the increase in cathode efficiency. It is suggested that chromic acid first forms an insoluble film on the cathode, while in higher concentrations it actually reacts with the base metal. W. BLUM.

Non-Poisonous Plating Baths, KASSMANN, *Chem. Ztg.*, **59**, 904 (1935) —The author summarizes the baths proposed to reduce the poison hazard in plating, as follows: (1) Schlötter's iodide baths for depositing silver and copper. (2) Schlötter's thocyanate baths for silver and copper. (3) Fink and Wong's copper-oxalato bath. (4) Gockel's thiourea bath for silver and copper. (5) Acid cadmium baths with addition agents. (6) Acid zinc and tin baths with addition agents. (7) Schlötter's violet chromium chloride bath with chromium anodes and a superposed alternating current. W. BLUM

Experiments to Determine the "Index of Uniformity of Thickness" and the "Throwing Power" of Nickel and Chromium Plating Baths, A. PORTEVIN and M. CYMBOLISTE. *Quartorzieme Congres de Chimie Industrielle*, (14th Congress of Industrial Chemistry.) Paris, Oct. 21-27, 1934 Vol. **2**—The authors make numerous experiments with a rectangular bent cathode divided into a number of parts, on which the deposits can be weighed separately, in the effort to get some ratio that will be a measure of throwing power. They conclude that even their best arrangement is not satisfactory for regular tests, and announce their intention to develop some other form of apparatus for this purpose. W. BLUM

Detection of Pores in Zinc Coatings on Steel, G. GARRE. *Arch. Eisenhutten* **9**, 91-94 (1935-36)—A method is proposed in which the specimen is made the anode in a solution containing 40 g/l (5 oz/gal) of potassium ferrocyanide, and 2 g/l (0.3 oz/gal) of magnesium sulphate. A platinum cathode is used and a potential of 4 volts is applied. Gas bubbles appear at any pores in the zinc coating on the anode specimen, but cease to form when the iron exposed at the pores is coated with Prussian blue. (Through *CA* **29**, 6844 (1935)). (NOTE—Experience shows that small pores in zinc coatings have little if any effect on their protective values. W. B.) W. BLUM.

Rhodium Surfaces for Metal Reflectors, BLASIUS BART. *Product Engineering* **6**, 308 (1935)—A brief description (with illustrations) is given of the manufacture of large metal reflectors by depositing copper and nickel upon the silvered surface of a glass mole having the desired curvature. The reflecting surface of the deposited reflector is then coated with rhodium, which is harder than silver, resists tarnish and does not permit adherence of slag droplets that may be thrown off from the arc used as a source of light. Rhodium has slightly less initial reflectivity than new silver for visible light, but retains its value while the silver deteriorates from tarnish. Rhodium has the highest reflectivity of any metal over the entire range, including ultra violet. W. BLUM.

Effect of Alkali Detergents upon Metals, Aluminum, Copper, Tin and Zinc, CHESTER L. BAKER. *Ind. Eng. Chem.* **27**, 1358 (1935)—The effects of various alkaline substances used in cleaning metals, for example preparatory to plating, were determined by immersing cleaned strips of the metals in sealed bottles containing the solutions and kept at 60° C. (140° F.). The metals were examined at intervals for visible etching or attack, and were

finally weighed to determine the amounts of metal removed. Tests were made with trisodium phosphate, sodium carbonate, sodium hydroxide, sodium metasilicate and liquid silicates containing different ratios of silica and soda. It was concluded that, under the conditions used, all of these metals were less attacked by silicate solutions than by the other alkalies, with the exception that sodium carbonate had less effect on zinc. It is suggested that the metals may be protected by adsorbing on their surfaces very thin films of silica, which do not however interfere with subsequent plating. When a silicate containing relatively less alkali than sodium silicate is desired, it may be obtained by adding to the metasilicate an acid salt such as mono-sodium phosphate or sodium bicarbonate. W. BLUM.

Chromium Plating Practice (Die Praxis der Verchromung), W. BIRETT. 76 pp., 21 illustrations. M. Krayn, Berlin, Paper-bound, 3.50 marks, (approximately $1.40)—The author set as his goal the preparation of a concise simple description of chromium plating for the benefit of persons without a technical education who are engaged in this field. He has accomplished this without using any chemical or mathematical formulas, and without referring to original publications except in a few cases where illustrations were reprinted from them. The tabulation of defects and remedies will be of considerable value to electroplaters. No methods of chemical analysis are included but empirical tests for the content of sulphate and for throwing power are described.

The book is of interest to Americans who desire to compare the plating practice here and abroad. For the most part the German practice is very similar to the American. A few differences are of interest. For example, the customary American use of lead linings and lead heating coils in the plating tanks is not approved. The recommended thickness of chromium over nickel for appearance (p. 29) is 0.001 mm (0.00004 inch) which is about twice that generally used in America.

The few references to theories are not always well founded. For example the statement (p. 36) that nickel is used as an intermediate layer between the base metal and chromium because its coefficient of expansion is intermediate between those of the two metals, may be valid for plating on brass, but hardly on steel, as nickel has practically the same coefficient as steel.

One of the decided limitations of the booklet is its frequent reference to commercial firms for further details. For example, a description of "black chromium plating" occupies 4 pages, but makes no specific reference to the composition of the solution except that it is patented! W. BLUM.

Finishing Vacuum Cleaner Parts, by F. L. PRENTISS. *Iron Age*, Vol. **136,** No. 22, Nov. 18, 1935—This is a general article on buffing Royal Cleaners at the P. A. Geier Company. Practically all buffing is done by hand on die castings, permanent mold castings, stampings and sand castings. Felt polishing wheels are not lubricated for steel and are lubricated with paraffin oil for aluminum. Steel tubes for cleaner handles are polished by holding them between a pair of rolls strapped to the operator and run back and forth along the wheel. E. T. CANDEE.

Wooden Pickling Tanks, by PAUL W. BENNINGTON. *Steel,* Vol **97,** No. 23, Dec. 2, 1935—Long leaf yellow pine is the best wood for pickling tanks for strength and acid resistance.

Douglas Fir and Cypress do not stand up as well. Clean pine with sound knots only, containing a maximum of pitch is the best. Construction details, data on size of tie rods and alloys to use are described.

The article contains all information necessary for the construction of wood tanks. E. T. CANDEE.

METALS AND ALLOYS ABSTRACTS

1. Finishing Metal Products. H. R. SIMONDS MCGRAW. Hill Book Company, New York—In the words of the author, "The average manufacturer knows less about finishing than any other link in his production chain." This book is offered to point the way to more attractive finishes and more efficient means of producing them. Part I is devoted to sales and commercial aspects of various finishes. Part II is concerned with various phases in preparation of metal surfaces prior to application of the finish. Succeeding parts cover polishing and buffing, plating, spraying, painting and special finishes. The book differs from the usual technical book in absence of numerous references to other work. The subject matter is very clearly represented and should appeal to executive, superintendents and others interested in results rather than details of operation.

PHIL J. RITZENTHALER.

2. Synthetic Enamels as Bake Finishes. *Industrial Finishing.* RAY C. MARTIN. Vol. **10,** May, 1934, p. 13-14—Discusses methods and procedure for applying one and two coats of synthetic enamels.

PHIL J. RITZENTHALER.

Influence of Bath Temperature on Chromium Hardness, by R. J. PIERSOL, PH. D. *Metal Cleaning and Finishing,* November, 1935—The cathode efficiency of a chromium bath increases with increase of current density, but decreases with increase of temperature. The two factors very nearly balance each other. The best conditions for bright deposits may be indicated by a line representing 13 percent. current efficiency. Maximum hardness of deposits secured from the experimental bath increase with increase of temperature. The article contains several graphs indicating that the addition of the borate radical affects the bath characteristics and is of advantage in securing harder deposits. E. T. SHEEHAN.

The Use of Fixtures in Production Polishing, by FRED B. JACOBS. *Metal Cleaning and Finishing,* November, 1935—Automatic polishing machines have proven advantageous in handling certain types of work. However, ninety-five percent. of polishing is done manually. With work of this type inexpensive fixtures can greatly expedite production. The author describes various types of clamps, spinning chucks, holders, etc., that facilitate handling.

E. T. SHEEHAN.

Business and Social News

BRANCH NEWS

Educational Activities

WATERBURY BRANCH

The regular meeting of Waterbury Branch A. E. S. was held Friday evening, Jan. 10th, in Engineers Hall. President Tennant Elwin presided. Minutes of previous meeting were read and approved. Communication from Chairman of the Educational Committee, offering the services of a speaker for a future meeting, was received and referred to the lecturer of the Branch. Application for associate membership was received from John S. Dixon of the Russell & Erwin Co. Routine business being finished, Pres. Elwin introduced the speaker of the evening, Lionel Cinamon, President of the Special Chemicals Corp., who gave an interesting talk on Rhodium Plating. The speaker described the metal as having been discovered by Wollaston in 1804, and occurs as an alloy in Platinum ore and Osmiridium. In the fused condition it is a brilliant white metal with a blue cast. An interesting description of the methods used in refining the metal were given. The electro-deposition of Rhodium has been known for several years, and is becoming popular as an ornamental and protective coating. Stated that Rhodium does not oxidize at warm temperature, and sulphides have no effect on it. In compact form it is not attacked by aqua regia. Gave an account of his experience with the various baths, and in his estimation, the phosphate bath was the best. This bath in proper condition gives a soft, pleasing white color and has the shade of a diamond. The methods of testing were also dwelt on. A good sized audience was present, and all enjoyed the talk and discussion which followed. A vote of thanks was extended the speaker, who was accompanied by Messrs. Sterling and Davis of New York.

W. F. GUILFOILE, *Secy.*

LOS ANGELES BRANCH

Minutes of the Los Angeles Branch A. E. S. held at the Rosslyn Hotel Dec. 11th, 1935. President E. R. Williams presided.

Following the roll call the minutes and financial report of the preceding meeting were read and accepted.

One member sent word that he wished to drop out of the Society. It was suggested that the secretary send him a statement for $6.00, the amount he is in arrears, and write him a letter of regret at his leaving the Society.

The Secretary read a letter from E. J. Wright, one of our Australia members. The members voted to send him the 1934 convention report owned by the Branch to Mr. Wright.

Bills amounting to $62.46 were read and ordered paid.

It was suggested that the Branch put on a card party some time in February. Rynkofs, Thornton, Merigold and Francis were appointed as Committee to arrange the details.

The meeting was then turned over to the Librarian, Ray Bray. The following questions were found in the box:

Q. How can a piece of brass be plated with black nickel?

A. Strike in regular nickel solution first. Then plate in black nickel.

EARL COFFIN, *Sec.-Treas.*

MILWAUKEE BRANCH

The Milwaukee branch A. E. S. held its regular meeting January 9, 1936 at Lipps Hall. President Bob Stuernagel in the chair. A large attendance was present. Minutes of the previous meeting were approved as read. Two applicants were elected associate members. Mr. Dan Wittig, chairman of the Milwaukee branch "Smoker", announced Saturday, March 21, the date for the smoker, the time 7 P.M. sharp. The place Schroeder Hotel, Crystal Ballroom. There will be the very nominal charge of $2.00 per person. The educational committee, Henry Bornitzke, Al. Hermansen. Hotel committee, Bob Steuernagle, Paul Krause. Entertainment committee, John Miszewski, Jr., Jack Geissman. Master of ceremonies, Pat Sheehan. The reading of Mr. Tingley's articles by Pat Sheehan helped considerably in putting the articles over as they should be. We all agree there is a wealth of help in these articles for the man who will stop to analyze himself.

R. C. BINDER, *Sec.-Treas.*

DETROIT BRANCH

A regular meeting of the Detroit Branch, The American Electro-Platers' Society, was held in the Hotel Statler, at 8:00 P.M. on Friday evening, January 3, 1936, with the President W. W. McCord presiding. There was a very good attendance.

The meeting opened with the reading of the minutes of the previous meeting which were approved as read.

The following applications for membership were reported on favorably by the Board of Managers:

Mr. Wilson White, 6177 Martin Ave., Detroit, Mich., Active, Reinstated; Robert Leonard Redmond, 4559 Wesson Ave., Detroit, Mich., Active; Carl E. Heussner, 672 Gladstone Ave., Detroit, Mich., Active; Wm. Baird Gertz, Mich. College Mining & Tech., Houghton, Mich., associate; Martvig J. Moll, 409 Curtis Bldg., 2842 W. Grand Blvd., Detroit, Mich., Active. An application for membership by Edwin Lacey, 11 McLean Ave., Highland Park, Mich., was received and referred to the Board of Managers for action. Mr. John Lee, 13610 Linnhurst Ave., Detroit, Mich., Resigned.

There being no further business to come before the meeting, the meeting was turned over to a social gathering. There were refreshments, and everyone present had to sign their name to slips which were tossed into a hat, and as their names were drawn out one at a time the person whose name was read had to sing a song, whistle a tune, dance a jig or tell a story. There were quite a few names drawn. Of course, there was not time for everyone to be called on. However, among those who were called were W. W. McCord who had several good stories to tell; Mr. Harry Blum also told a story, and Bill Lovell told about the "other six fellows", and Charles Beaudien was also called upon. Mr. Jimmy Germaine when his name was called was asked for a harmonico solo. The harmonica however which had been furnished to him took too much wind to blow. A little later someone found one that he could blow and he gave us quite a lot of entertainment. Mr. Sol Berg also gave us a story. Some of the boys had a good game of poker while others enjoyed bridge, and altogether, with the President's speech being on the radio, it was a very entertaining meeting.

The meeting adjourned at 12:00 P. M.

T. C. EICHSTAEDT, *Sec.-Treas.*

CHICAGO BRANCH

Chicago Branch A. E. S. held their 24th Annual Educational meeting and Banquet at the Stevens Hotel on Jan. 18, 1936. There were 560 people there and a fine time was had by all. Excellent turkey dinner and a very fine floor show and a fine orchestra for dancing was served to our members and visitors.

Chairman H. A. Gilbertson and his committees are to congratulated for the largest and best banquet Chicago Branch has ever had.

The Educational Session started at 2:30 P.M. in charge of the Librarian, Past President O. E. Servis, and he is to be congratulated for securing a fine lot of papers, which were ably discussed by the attendance. Messrs. H. K. Work, M. H. Longfield, J. Hay, and O. J. Sizelove surely should be thanked for the manner in which they presented their subjects.

Mr. P. Sheehan, Vice-President of the A. E. S., also Mr. W. Phillips of A. E. S. Research Committee, addressed the meeting on the Education and the Research of the A. E. S. and were attentively received by the audience.

As usual there was a very large delegation from Milwaukee Branch headed by D. Wittig, B. Stuernagel, J. Geisman, H. Binder, E. Werner, S. K. Williams, and R. Binder.

The supply companies headed by Hanson Van Winkle Munning, Kocour Co., Allied Industrial Products, Belke Mfg. Co., Advance Wheel Co., Matchless Metal Polish, L'Hommedieu & Sons Co., E. I. Dupont de Nemours, R. & H. Div., Udylite Process Co., G. A. Stutz Co., Clinton Lacquer Co., LaSalco Co., J. B. Ford Sales Co., Mass & Waldstein Lacquer Co., Trojan Co., Brevolite Zapon Co., Meaker Co., Egyptian Lacquer Co., J. Miller Co., Grand Rapids, Dowd Co., Milwaukee, Olson Lac. Co., Williamsville Buff Co., F. Gumm Chemical Co., G. J. Nikolas Co., Crown Rheostat Co.

Entertained many out of town guests which added much to the gaiety and pleasure of the party and Chicago Branch thanks them all for the loyal support and interest shown in all our social affairs.

The register showed members and visitors from the following Branches: Milwaukee, St. Louis, Grand Rapids, Detroit, Newark, Boston, and if this is a criterion to gauge the attendance at the annual convention at Cleveland June 1, 1936, well, there should be about 1000 guests listed on their register.

J. W. HANLON, *Sec.*

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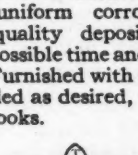

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CHICAGO BRANCH

The regular monthly meeting of Chicago Branch was held Sat., Jan. 11, at the Atlantic Hotel.

President F. Herbst presided and all other officers present.

Mr. J. Deyne and Mr. B. F. Bower were elected to associate membership.

Mr. Gilbertson reported that Mr. T. Kennedy was on the sick list but was improving and it is hoped that he will soon be back in normal health.

The following applications were read and committees appointed on same: Mr. G. A. Bock, Jr., Mr. J. S. Edwards, Mr. E. H. Lyons, Jr., and Mr. L. B. Doll.

The Librarian found the following questions in the question box:

No. 1. Is there such a thing as black chrome plate? How is it done?

Answer. Black chrome is made by dipping the chrome plated part in molten cyanide at 1500% then rinse in hot water and dry.

No. 2. What advantage is Ammonium Sulphate in a Nickel solution?

Answer. It is a conducting salt.

No. 3. What pickle will remove the oxide caused by soldering stainless steel?

Answer. A pickle of 50% Acetic acid and 50% Nitric acid.

No. 4. How can carbon be removed from solid copper ice cream dippers to leave a clean surface for hot tinning dip?

Answer. Heat up the article and dip in a 50% Sulphuric acid dip, then pickle in a nitric dip, then bright dip.

No. 5. Is ferrous sulphate better then lime to purify nickel solutions and what percentage is used?

Answer. Many suggestions offered but thought that lime is the best.

No. 6. What causes a deposit of green powder, probably nickel hydrate from a nickel solution on points, and edges of work when high current densities are used?

Answer. The pH is too high and not enough Boric acid in the solution.

No. 7. What is the best way to remove carbonates from a cyanide copper solution?

Answer. Freeze the solution and the carbonates will come out.

J. W. HANLON, *Sec.*

BINGHAMTON-ELMIRA BRANCH

Our Jan. 20th meeting started at 6:30 with dinner being served to fifty members and guests. We were especially pleased with the attendance.

Our meetings are creating considerable interest in plating and in the A. E. S. Fifteen of the men attending had to travel at least 60 miles and some as far as 100 to get here. To top off the trip we had about 18 inches of snow the day before. Enough said!

The business meeting was brief. Mr. L. C. Connadi, Mr. Roy Soper, and Mr. A. Reynolds were elected as the Board of Managers.

The application of Harry Herlikoper was to take the usual course.

It was decided we would hold one meeting a month, to be a dinner meeting starting at 6:30 the first Monday of each month, the present meeting place to be the Y. M. C. A. in Binghamton.

Our Librarian, Jack Hornett,—and believe me, we sure did pick a live wire—was right on the job with a question box and then introduced the speaker, Mr. R. O. Hull of Grasselli Chem. Co., who gave us a very interesting talk on Bright Zinc Plating.

Binghamton-Elmira Branch is very thankful to Mr. Hull and to the Grasselli Chem. Co. for the valuable information secured.

LARRY MEYER, *Sec.*

BINGHAMTON-ELMIRA BRANCH

The first meeting under our temporary charter was held Monday, Jan. 6, at the Y. M. C. A. in Binghamton. Dinner was served at 6:15 to thirty members and guests.

The meeting was called by Austin Fletcher who orgarized our Branch.

We have ten active and two associate members at present, with many good prospects for increasing our membership 100%.

The following officers were elected: President, A. Fletcher; Vice-President, F. Merritt; Secretary-Treasurer, L. Meyer; Librarian, J. Hornett.

The speaker for the evening was Austin Fletcher, who talked on Barrell Plating Cadmium. A paper read by him at the Bridgeport Convention. After many questions the meeting was adjourned at 9:15 P.M.

LARRY MEYER, *Sec.*

HARTFORD BRANCH

The Hartford Branch of the A. E. S. held its regular monthly meeting on Monday evening, January 13, 1936, at the State Trade School, 110 Washington St., Hartford, Conn.

The meeting was called to order at 8:15 with Past President Beloin in the Chair. Minutes of the previous meeting were read and accepted. No bills or communications were presented. The resignation of Mr. Edw. Fleming was accepted.

We had as speaker for the evening, Mr. N. E. Promisel, Engineer for the International Silver Co., of Meriden, Conn. His topic for the evening was "The Structure of Electrodeposits and Basis Metal Surfaces."

His talk was accompanied with antern slides which were both instructive and interesting. In conclusion, Mr. Promisel was given a rising vote of thanks.

The meeting was attended by twenty-four members and was adjourned at 10:15 P.M.

V. E. GRANT, *Sec.*

ANDERSON BRANCH

Anderson Branch held their regular dinner meeting Monday evening, January 13th, at the Y. M. C. A.

A good attendance, which included most all of our new members and several guests, enjoyed an interesting lecture on "Hydrogen Brazing", which was illustrated with slides.

This process of Brazing employs the use of copper plating in some cases and was highly interesting to our members. A vote of thanks was extended to the author of this paper, Mr. Fred Carl of Delco-Remy Corporation.

Following the members' discussion of the paper, and a general get-together, meeting was adjourned at 9:00 P.M.

J. MINTON, *Sec.*

CLEVELAND BRANCH

The regular monthly meeting of the Cleveland Branch of the American Electro-Platers' Society was held at Hotel Carter, Saturday January 11th, 1936.

The meeting was called to order by our President, Mr. William Scott, at 8:15 P.M.

This was an open meeting, the ladies being present.

The minutes of the December meeting were approved as read.

An application for active membership was made by Mr. Michael Rubin of the Warren Steel Products, and was turned over to our Board of Managers.

The balloting of Mr. Fred Carlson was next in order, he being elected.

The secretary was then instructed to notify Mr. Carlson of his election to the Society.

Mr. Thompson then reported the change of dates for the Convention from June 8th to June 11th inclusive, to June 1st to June 4th inclusive, the change becoming necessary due to the Republican Convention coming to Cleveland.

Mr. Thompson wrote to the parent body to receive their sanction on the changing of the dates, but they had this all taken care of before our meeting.

Also got in touch with Mr. Glouster, Manager of the Cleveland Convention Headquarters, and he agreed to reprint the stationery due to the change in dates. It was regularly moved and seconded that Mr. Thompson take care of this change on the stationery.

Mr. Thompson as Chairman of the Publicity Committee reports progress.

Mr. Hull, Chairman of the Transportation Committee reports of the various plants to visit and trips to be made in and about Cleveland.

Mr. Lyons, Chairman of the Banquet Committee reports progress and suggested that we budget our income in order to find out how much money we could allot to each committee. At the next meeting each chairman will bring in his budget so that we can discuss this matter more thoroughly.

Mr. Scott of the Entertainment Committee reports of his conversation with Mr. Dean of the Carter Hotel, in regard to furnishing entertainment at the banquet. Music and 20 acts of entertainment for $300.00. It was regularly moved and seconded that the Society spend this amount for entertainment at the banquet.

The Ladies' Program was next after numerous suggestions were made of places to visit. It was decided to have the ladies present at the next meeting at which time they would elect a Chairwoman, and determine the sessions in which they would have to furnish entertainment for the ladies at the convention.

The Secretary was then instructed to get in touch with local badge manufacturers and have them submit samples and prices for the next meeting.

There being no further business the meeting adjourned.

W. E. O'BERG, *Sec.-Treas.*

PHILADELPHIA BRANCH

Philadelphia Branch held its regular monthly meeting on January 17th, 1936, at the Harrison Laboratory, U. of P.

President Hirsch opened the meeting with a lecture illustrating the Polarization determined by a Haring Cell. This was received with a great deal of attention.

Mr. M. R. Berry, of the Electric Products Co., Cleveland, O., gave an instructive resume of our Plating Generators and topped this with one of the best talks on Social Health conditions of the industrial workers, that we ever heard.

A rising vote of thanks was given both speakers for their efforts in our behalf.

Philadelphia Branch has been very fortunate this year in having very interesting and educational lectures, and the Branch Officers take this opportunity of thanking the members for their co-operation as shown by the large attendance at each meeting, and also by the support they are giving our Supreme Vice-President, Jos. E. Underwood, by the number of applications being turned in, so lets keep up this good spirit and we will again be back in line where we were in '29.

"The Tentative Specifications for Electrodeposited Coatings of Zinc,

Cadmium, Nickel and Chromium on Steel" issued by the Supreme Society in conjunction with the A. S. T. M. have been received from Supreme Editor Wm. J. R. Kennedy, and the same will be mailed to each of our members with the next copy of the "Quaker City Platers Reminder".

Messrs. J. E. Underwood, H. Snyder and W. Reynolds were appointed a committee to make arrangements for holding a "Spring Meeting" up or near Lancaster, Pa., and to report the progress of the same at the Feb. 21st meeting.

Supreme Vice-President Jos. E. Underwood will be the guest speaker at the Feb. 21st meeting and has a very important message to deliver to all our members and which is very timely and educational to all concerned in the Electroplating Industry.

President Hirsch will open the meeting with a talk on the "Measurement of Resistivity of Electrolytes" and which fits in with the series of lectures President Hirsch has been giving at each meeting.

President Hirsch spoke of the advantages to be gained by the Branch taking out a membership at the Franklyn Institute. It was decided the Branch take out such a membership.

GEORGE GEHLING, *Sec.*

SPRINGFIELD BRANCH

A meeting of the Springfield Branch A. E. S. was held Jan. 13, 1936, at the Indian Social Club Room.

President Sidel conducted the meeting with eleven members present. The minutes of the previous meeting were read and approved. The applications of eleven new members were acted upon and all were accepted as members.

The following are names of those accepted:

Thos. Stephenson, Associate Member, Westinghouse Electric Co.
Joe J. Mongeau, Active Member, American Bosch Corp.
Frank J. Rickus, Associate Member, Westinghouse Electric Co.
Anthony Dighello, Active Member, Int. Casket Hardward Co.
Ernest Sagar, Active Member, L. D. VanValkenburg Co.
Henry Delarm, Active Member, Indian Motorcycle Co.
James E. Calvert, Active Member, L. S. Starrett Co., Athol.
Arthur LaChance, Associate Member, T. J. Murray Co.
Clarence Deos, Active Member, T. J. Murray Co.
Jos. W. Russell, Active Member, Gilbert & Barker Co.
Walter Barrus, Active Member, Fiberloid Corp.

Mr. Henry Delarm was elected Secretary-Treasurer. Mr. Walter Barrus was elected Librarian.

Mr. W. J. R. Kennedy made an announcement that any member that has changed their home address should notify the editor that the mailing list of the MONTHLY REVIEW could be revised.

There was some discussion as to holding a social gathering and inviting the members' wives, after which the meeting was adjourned subject to the call of the President.

H. DELARM, *Sec.*

ROCHESTER BRANCH

The regular monthly meeting of the Rochester Branch was held at the Seneca Hotel on Friday night Jan. 17. As it was an open meeting President Kohlmeier immediately introduced the speaker of the evening, Mr. Henry Norgren of the Detroit Rex Products

Co., who gave an interesting talk on the Degreaser and its particular uses in the plating industry. Mr. Norgren began his talk with a discussion on cleaning before the advent of the degreaser in which he mentioned the use of at least two alkali cleaners, one of which is usually an electro-cleaner previous to which some such solvent as gasoline or benzine were probably used. This of course was a very unsatisfactory way to clean not only because of the operations involved but also because of the fire hazard, and the fact that they soon became contaminated and of necessity had to be thrown out. Then he told of the first degreasing unit which was solely a vapor machine. This of course was very good in removing the soluble oils but would not remove all the solids and necessitated the wiping of the pieces after degreasing. Then came the immersion type machine but this was also unsatisfactory in that as soon as the solvent became contaminated with grease, dirt and oil the work was left with a thin film of the contaminents. Then the three phase machine was introduced and is now giving very satisfactory results. He stressed the point that there is still a lot of misunderstanding about the use of the degreaser in that some platers assume that it is proper and that satisfactory results would be obtained by going directly from the degreaser into the plating tank. This is an erroneous idea except in a few rare cases. It is still the best and safest policy to go into an alkali cleaner after degreasing. Degreasing does not necessarily save any operations but does practically eliminate any possibility of rejects because of insufficiently cleaned work.

After the talk many questions were asked which Mr. Norgren gladly answered. A rising vote of thanks was given and an invitation to come back again sometime.

The business meeting was then brought to order by President Kohlmeier. After the reading of the minutes and communications under new business it was decided to hold the annual Bowling Party in the very near future and the following committee was appointed to make all arrangements: Clarence Reama, chairman; Jack Snyder, Dan Kennedy, and J. Elster. Mr. Daniel Kennedy of Taylor Instrument Co., was elected as an associate member and the following applications were received and ordered published: Mr. Henry Norgren, 112 Alden St., Syracuse, N. Y., associate member; Mr. Ray J. Berghold, 643 Post Ave., Rochester, N. Y., associate member; Mr. Frederick H. Bruening, 1372 Monroe Ave., Apt. No. 21, Rochester, N. Y.

JUDSON R. ELSTER, *Sec'y.*

NEWARK BRANCH

The regular meeting of the Newark Branch, A. E. S., was held at the North End Club on Friday evening, January 17, 1936. President Samuel Taylor called the meeting to order at 8:30 P.M. The following officers were present: President, Samuel Taylor; Vice-President, Josepk Kotches; Treasurer, Nelson Sievering; Sergeant-at-Arms, George Klink; Trustees, George Wagner, Cyril Hamlin, and Sam Glickenhaus. Since the secretary, George Reuter was absent, George Wagner was appointed secretary pro tem for the evening and Joseph Kotches was appointed librarian by the chair.

Mr. Nelson Sievering was elected assistant secretary by a majority vote. Mr. Horace Smith, chairman of the banquet committee reported progress for the coming banquet which is sched-

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uled to take place at the Hotel Douglas, April 18, 1936.

The meeting was then turned over to the librarian who introduced the speaker for the evening, Dr. C. L. Mantell of Pratt Institute. Dr. Mantell gave a very interesting talk on new developments in Electro Chemistry and Electro Plating. He pointed out the corrosive resistance and decorative qualities of cobalt cadmium nickel and zinc. He also mentioned that Tin was being plated bright to almost any thickness, and bronzes such as copper and tin, or copper tin and nickel were making rapid strides in the plating industry.

Dr. Mantell explained how metal powders such as copper powders, aluminum powders, or even chromium powders were being compressed into solid metal and after annealing were just as strong as castings. He also explained how those powders were made electrolytically.

A question was asked how to plate a bright zinc. Dr. Mantell explained that bright zinc plating was not a new method and that a bright deposit could be obtained from any standard zinc plating solution by adding cobalt or cadmium in small amounts to the plating bath.

Dr. Mantell was given a rising vote of thanks for his talk and the meeting adjourned at 10:45 P.M. Twenty-four members were present.

GEORGE WAGNER, *Secy protem.*

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BRIDGEPORT BRANCH

Annual Banquet and Educational Session

Stratford Hotel, Bridgeport, Conn.

Saturday, March 14, 1936

MR. WALTER MEYER, in charge of the Educational Program, has arranged for a very interesting afternoon session. The papers to be read should interest the attending members. Among the speakers will be: Dr. R. R. Rogers, Columbia University, Department of Chemical Engineering, will read a paper on "Chrome." W. M. Phillips, General Motors Company, will show the Pictorial Projectoscope, showing plating solution at work on the screen.

Banquet, 7 P. M.

The Banquet Committee has planned a first class affair, good entertainment, dancing and music by a high class orchestra. All to be in the main ballroom.

Tickets may be obtained in advance from Charles C. Costello, 1285 Boulevard, New Haven, Connecticut. $3.00

THE COMMITTEE

Joseph Sexton.....Chairman	William Stratton..Entertainment
Charles Costello.....Sec.-Treas.	George Wagstaff.....Banquet
William Flaherty, Entertainment	Walter Meyer.....Educational

Eugene Phillips.....Publicity

Membership Report

To December 18, 1936

ELECTED

Daniel Kennedy, Taylor Instrument Co. Rochester, N. Y.
Associate Rochester Branch

J. Deyne, 448 Wrightwood Ave., Chicago, Ill.
Associate, Chicago Branch

B. F. Bower, c/o Howell Company, St. Charles, Ill.
Associate, Chicago Branch

Fred M. Carlson, American Tinning and Galvanizing, Erie, Penna. Active, Cleveland Branch

John Vitale, Olean Plating Co., Olean, N. Y.
Active, Binghamton-Elmira Branch

Eugene J. Surback, 1833 N. Newkirk St., Philadelphia, Penna.
Active, Philadelphia Branch

H. Clay Brubaker, 24 N. Mary St., Lancaster, Pa.
Active, Philadelphia Branch

Arthur Sabine Pasley, Fescol Ltd., 101 Grosvenor Rd., London, S. W. 1, England Associate, Baltimore-Washington Branch

Dr. Chas. Kasper, Bureau of Standards, Washington, D. C.
Associate, Baltimore-Washington Branch

Christopher M. Keller, 1124 Morse St., N. E., Washington, D. C.
Associate, Baltimore-Washington Branch

John Binns, 1524 Wisconsin Ave., N. W., Washington, D. C.
Active, Baltimore-Washington Branch

Wm. P. Scherrer, 103 Kingston Ave., Capitol Heights, Md.
Active, Baltimore-Washington Branch

Lancaster Lowry, Washington Navy Yard, Washington, D. C.
Associate, Baltimore-Washington Branch

O. W. Tomlinson, 605 14th St. N. E., Washington, D. C.
Active, Baltimore-Washington Branch

Carroll T. Thomas, 1312 23rd St., S. Alexandria, Va.
Associate, Baltimore-Washington Branch

Wm. R. Davis, Seat Pleasant, Md.
Associate, Baltimore-Washington Branch

Wm. R. Mullikin, 1423 N. Patterson Ave., Baltimore, Md.
Active, Baltimore-Washington Branch

John Paul Denham, 401 Decatur St., N. W., Washington, D. C.
Associate, Baltimore-Washington Branch

Wm. F. Drechsler, 616 15th N. E., Washington, D. C.
Associate, Baltimore-Washington Branch

Conrad Bertholdt, 3213 Lyndale Ave., Baltimore, Md.
Active, Baltimore-Washington Branch

Casper S. Wolf, U. S. Navy Plating Shop, Naval Gun Factory, Washington, D.C. Associate, Baltimore-Washington Branch

George C. Muscio, 16 Cherry Ave., Waterbury, Conn.
Associate, Baltimore-Washington Branch

Melvin E. Lutzke, 2795 S. Ellen St., Milwaukee, Wisc.
Associate, Baltimore-Washington Branch

Florian Bertling, 2009 S. 11th St., Milwaukee, Wisc.
Associate, Baltimore-Washington Branch

R. L. Redmond, 4559 Wesson Ave., Detroit, Mich.
Active, Detroit Branch

Martvig J. Moll, 409 Curtis Bldg., 2842 W. Grand Blvd., Detroit, Mich. Associate, Detroit Branch

Wm. Bayard Gertz, Michigan Tech., Houghton, Mich.
Associate, Detroit Branch

Carl E. Huessner, 672 Gladstone Ave., Detroit, Mich.
Active, Detroit Branch

Joseph James Mongean, 53 Thomas St., Springfield, Mass.
Active, Springfield Branch

Anthony A. Dighello, Hazard Ave., Thompsonville, Conn.
Active, Springfield Branch

Ernest Sagar, 911 Armory St., Springfield, Mass.
Active, Springfield Branch

Henry Raymond Delarm, 330 Plainfield St., Springfield, Mass.
Active, Springfield Branch

James E. Calvert, 125 Water St., Athol, Mass.
Active, Springfield Branch

Clarence Deso, 18 Batavia St., Springfield, Mass.
Active, Springfield Branch

Joseph W. Russell, Chestnut St., East Longmeadow, Mass.
Active, Springfield Branch

Walter Douglas Barrus, 218 Franklin St., Holyoke, Mass.
Active, Springfield Branch

Thomas L. Stephenson, 521 Broadway, Chicopee Falls, Mass.
Associate, Springfield Branch

Frank J. Rickus, 40 Lincoln St., Chicopee Falls, Mass.
Associate, Springfield Branch

Arthur Ernest LaChance, 975 Main St., Springfield, Mass.
Associate, Springfield Branch

APPLICATIONS

Henry Norgren, 112 Alden St., Syracuse, N. Y.
Associate, Rochester Branch

Ray J. Berghold, 643 Post Ave., Rochester, N. Y.
Associate, Rochester Branch

Fredereck H. Bruening, 1372 Monroe Ave., Apt. No. 21
Rochester, N. Y. Rochester Branch

Harry M. Herdikoper, 76 St. Charles St., Johnson City, N. Y.
Associate, Binghamton-Elmira Branch

E. H. Lyons, Jr., c/o Meaker Co., 1629 S 55th Ave.
Cicero, Ill. Associate, Chicago Branch

J. S. Edwards, 2449 S. California Blvd., Chicago, Ill.
Associate, Chicago Branch

G. A. Bock, Jr., 177 E. Marion St., Elkhart, Ind.
Active, Chicago Branch

L. B. Doll, 631 Terrace Ave., Bethlehem, Pa.
Active, Chicago Branch

Edwin Lacey, 11 McLean Ave., Highland Park, Mich.
Active, Detroit Branch

John S. Dixon, Russell and Erwin Co., New Britain, Conn.
Associate, Waterbury Branch

D. M. Davis, Iron and Steel Pub. Co., Investment Bldg.,
Pittsburgh, Penna. Associate, Pittsburgh Branch

RE-INSTATED

E. T. Homan, 1118 N. 28th St., Camden, N. J.
Associate, Philadelphia Branch

Joseph Triska, 2533 98th St., East Elmhurst, L. I.
New York Branch

Anthony Messano, 2139 Eastern Blvd., The Bronx, N. Y.
New York Branch

Earl Savery, Los Angeles, Cal. Los Angeles Branch

Wilson White, 6147 Martin Ave., Detroit, Mich.
Detroit Branch

RESIGNED

John O. Lee, 13610 Linnhurst Ave., Detroit, Mich.
Detroit Branch

Membership Drive Barometer

Branch	Elected	Reinstated
Baltimore-Washington	17	
Springfield	11	
Binghamton-Elmira	10	
Philadelphia	9	3
Detroit	6	1
Chicago	4	1
Bridgeport	3	
Toronto	2	3
Pittsburgh	2	
Cleveland	2	
Waterbury	2	
San Francisco	1	
Los Angeles	1	3
Toledo	1	
Rochester	1	
Hartford		2
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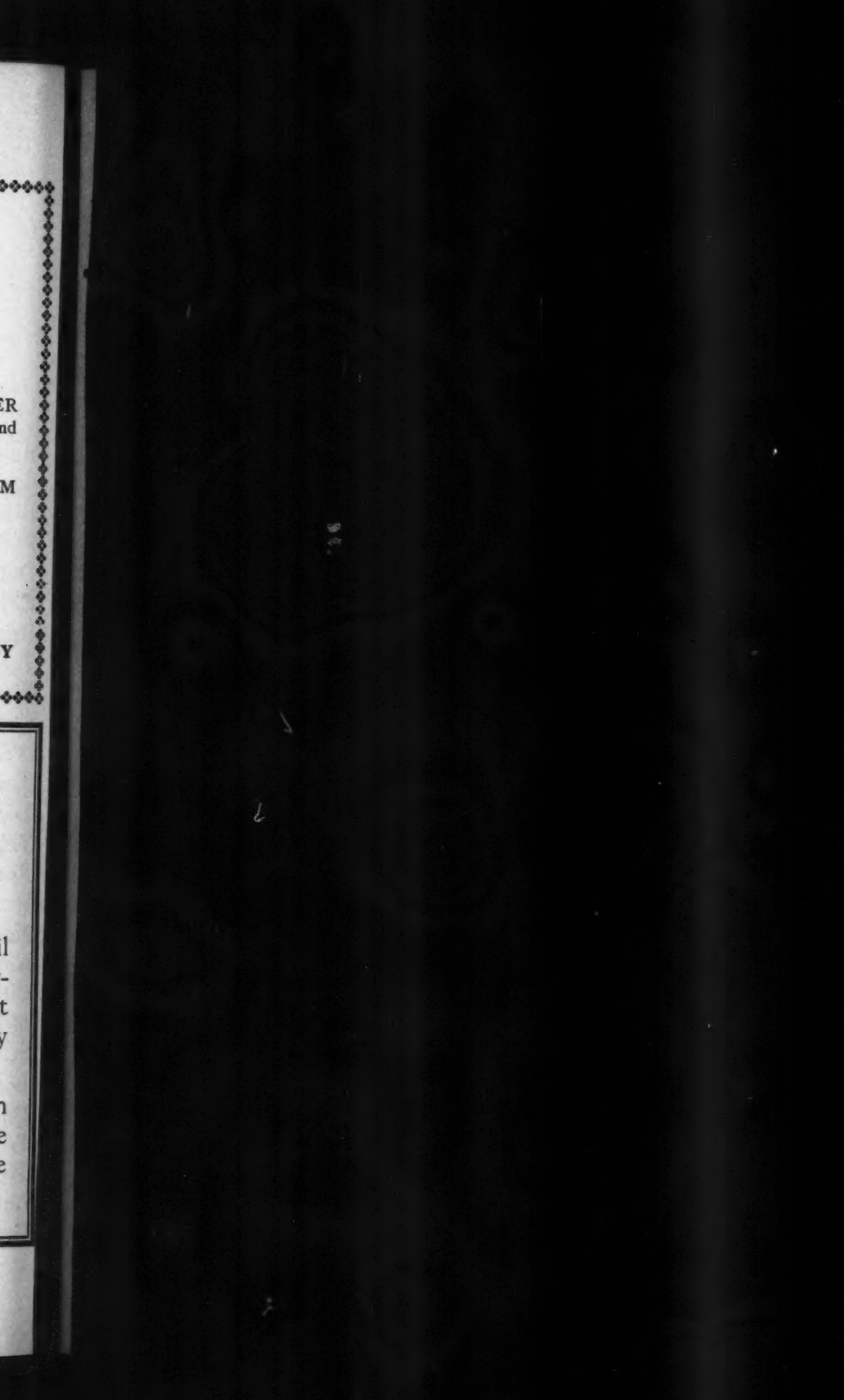
When proofs are desired copy must be sent in not later than the **10th** day of the month and the proofs returned to the Editor not later than the **25th** day of the month previous to publication.